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PRINCIPLES OF TAXATION.

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II.—THE PLACE OF TAXATION IN LITERATURE AND HISTORY.

ONE of the great historians of the present century has expressed disappointment at what he terms the "emptiness" of historical study, and accordingly inclines to the opinion that guidance in respect to human affairs in the future is to be sought for in present rather than in past experiences. Nevertheless, it would seem to stand to reason, that when any department of knowledge, especially one characterized by controverted questions, is to be comprehensively examined, with the prime object of determining the best methods for human action, it would not be expedient to attempt to discover or discuss any abstract principles which ought to govern such action, until at least a summary of facts derived from experience and essential to correct conclusions had been presented and made familiar, and, acting on this assumption, it is proposed next to ask attention—*first*, to the place of taxation, considered as a department of knowledge, in general literature; and, *second*, to some points of historical interest, growing out of the appropriation of states or rulers of the property of their citizens or subjects for real or assumed public purposes. It is believed that in this way the discussion at a later period of the principles growing out of the exercise by governments of this great prerogative may be facilitated and rendered more attractive.*

* "No man can learn what he has not preparation for learning, however near to his eyes is the object. Our eyes are holden that we can not see things that stare us in the face, until

POSITION OF TAXATION IN GENERAL LITERATURE.—All general treatises on political economy devote more or less space to the consideration of taxation; and there have been many publications in the nature of official reports, compendiums of tax laws, and their interpretation by legal tribunals, and special essays on particular forms of taxes. But, at the same time, notwithstanding the vastness and importance of the subject, its symbolism and exemplification of sovereignty, its influence for weal or woe on every citizen and on every industry, according as the power involved is properly or improperly exercised, and the part it has played in history, its position in economic literature is so comparatively insignificant that there is not a single publication at present in the English language which is entitled to be considered as a full and complete treatise; certainly none such as are readily at the command of every person desirous of becoming reasonably proficient in any of the other leading branches of learning. Prof. Cossa, of the University of Pavia, Italy, in a bibliography of taxation incorporated in a brief treatise on the Science of Finance, published in 1882, and brought up to the times by an American translation in 1888,* does not mention even one title of this character. And, although there are works on taxation more or less general in their scope in other languages—especially in French and German—and to some of which high merit is accorded, there are none which any considerable number of economists are willing to accept as standard or authoritative in all departments; the chapter on taxation in Adam Smith's Wealth of Nations constituting the only treatise which can possibly be regarded as an exception.† For such a result it is not easy to account. Possibly, owing to the want of accord among writers on economic and financial subjects, an opinion has come to prevail that no consistent treatment of the subject, as a whole, is possible; that the financial and industrial condition of nations or states differs so widely that no uniform rules of practice for the raising of revenue can be established; and, finally, if such a code of rules were universally accepted, the varying necessities of nations would com-

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the hour arrives when the mind is ripened; then we behold them."—*Emerson, Spiritual Laws, First Series of Essays, p. 139.*

* Taxation, its Principles and Methods. Translated from the Scienza delle Finanze of Dr. Luigi Cossa, Professor of the University of Pavia, Italy; with an Introduction and Notes by Horace White. New York: G. P. Putnam's Sons, 1888.

† "It is well known that during the period from Adam Smith to the close of John Stuart Mill's activity—that is, for fully one hundred years—English political economy treated the science of finance" (embracing the raising of revenue) "as nothing better than a scanty appendage. It is a significant fact that no work worth mentioning on the science of finance has yet (1889) been published in the English language, though some considerable contributions have been made to financial history."—*Cohn's Science of Finance.*

pel its violation, or complete abandonment, in periods of great emergency.

In the case of the United States the condition of the country previous to the civil war, as already pointed out, was very curiously such as to create great indifference to this, in common with almost every other economic or financial topic. The nation and the several States composing it were at the period referred to comparatively free from debt. All taxation was light. *Direct* taxation by the Federal Government had become a matter of history, no taxes of this character having been imposed for nearly half a century. Pauperism was mainly restricted to persons of foreign nativity, while to all who were willing to practice industry and economy, the ability to command a good subsistence, if not an ultimate competence, seemed comparatively easy. Why should a nation under such circumstances trouble itself about difficult and intricate problems in finance or political economy? And taking counsel of the proverb, "Sufficient unto the day is the evil thereof," the nation did not. But, with the advent of war in 1861, the creation of an enormous national debt, and a gigantic, unsystematic, and complex system of taxation, a resort to irredeemable paper money and the suspension of specie payments, the condition of things as above stated rapidly changed; and the questions and problems which in popular estimation were before insignificant have rapidly become so important, as to constitute not only the theme of never-ending popular discussion, but also the issues which mainly divide the national political parties of the country. And as illustrating in some degree the nature and strength of what may be termed the motor or impelling influences which have forced these changes in public opinion, what can be more pertinent than the fact that the State of New York alone now annually raises by taxation to meet the expenditures of State and local governments a sum ($91,232,012 in 1890) more than one half in excess of the net ordinary expenditures of the Federal Government in 1860 ($60,086,754). In this latter year the cost to the people of the United States for the maintenance of their national, State, and local governments was probably less than three dollars *per capita*. For the year 1890, an approximately correct estimate for like expenditures was $13.65 *per capita*.

These questions and problems have not, however, come up simultaneously for consideration, but have been gradually evolved, as it were, from the changing condition of affairs, and somewhat in the following order: *First*, the national debt and its transition from a miscellaneous to a consolidated character; *second*, the readjustment of the war system of internal taxation; *third*, the question of currency, specie redemption, and legal tender—on which topics alone more than three hundred separate publications,

books and pamphlets, exclusive of congressional speeches and newspaper articles, have been issued from the American press; *fourth*, the "Free Trade" and "Protection" question; *fifth*, the monetary metallic standard question; *sixth*, the relations of the State to common carriers, and the methods of internal intercommunication; *seventh*, the subject of local or State as contradistinguished from national or Federal taxation; on which latter topic, although it relates to methods by which the people of the United States at present annually contribute to local or State governments a sum nearly equal to the present total annual revenue of Great Britain from all imperial taxes, there had not been up to 1870, a single publication in the United States apart from official reports that pretended intelligently to discuss it. Since this date, however, a much greater interest has been manifested on this subject. Several publications of great merit, exhibiting the situation in its legal aspects, and the theories, controversies, and experiences of the past, have appeared;* and this interest has been especially intensified and popularized by the scheme of the so-called "single tax," which, if not originated by Mr. George, has been so ably advocated by him as to have attracted, previous to the development of the silver problem, more of popular attention on both sides of the Atlantic than any other economic topic brought forward during the present century.

Some better acquaintance with the literature of taxation than has hitherto been acquired by most educated men would seem to be essential to a full understanding of many of the great events in the world's history, inasmuch as nearly all great political revolutions have been primarily occasioned by the exercise of arbitrary power in compelling contributions of property from the masses by those in authority. Thus, going back to ancient history, the disruption of the Jewish monarchy and the secession of the ten

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* Of such publications the following are specially worthy of notice: A Treatise on the Law of Taxation, including the Law of Local Assessment, by Thomas M. Cooley, one of the justices of the Supreme Court of Michigan, 1876; A Treatise on the Law of Taxation, as exercised by the Government of the United States, by W. M. Burroughs, 1877; The Law of Taxation, by Francis Hillard, 1875 (three publications in which questions of political economy, as not necessarily involved in discussion of legal points, have received little consideration); The Shifting and Incidence of Taxation, 1892, Progressive Taxation in Theory and Practice, 1894, Essays on Taxation, 1895, by Prof. Edwin R. A. Seligman, of Columbia College, N. Y., three publications characterized by great historical research, and a repertory of information not otherwise readily accessible. Cohn, Science of Finance, a recent work of sufficient merit to warrant its translation from the German under the auspices of the University of Chicago, is nevertheless of such a character that it will never be generally read, or have the slightest influence on the mass of the people of a country like the United States, who select the legislators who determine what shall be the policy of their Government in respect not only of taxation but of all other fiscal or economic subjects.

tribes were due to the refusal of the successor of Solomon to accede to the demands of their representatives that he should abate the (tax) exactions of the preceding reign; and to his threat in response that he would make his yoke even heavier in this particular than his father's. And the first significant act recorded of the revolt that followed was the stoning to death of the man Adoram, who "was over the tribute," or the chief of the tax collectors.

After the Persian war, the states of Greece, united under what was termed the confederation of Delos, agreed to make contributions—i. e., pay taxes—to Athens, to be used by her for the common defense; and these contributions, assessed in the first instance by Aristides, whose reputation for justice commanded the confidence of all, occasioned no complaint. But finally Athens, having assumed the direction of the confederacy, not only increased the contributions beyond the assessments of Aristides, but also assumed the right to use them arbitrarily, notably for fortifying and beautifying the city. The result was a revolt, followed by the Peloponnesian war, and from that date and occurrence the decline of Athens, and indeed of all the states of Greece, is traceable.

Oppressive taxation prompted the so-called massacre of the "Sicilian Vespers" in 1282, resulting in the slaughter or expulsion of all the French from the island of Sicily.

The assumption and exercise of authority on the part of Pope Leo X in 1517, to enforce contributions for the rebuilding of the cathedral of St. Peter's at Rome was, as is well known, the primary cause of the disruption of the Roman Catholic Church, the Protestant secession led by Luther, and the almost innumerable wars and social disturbances that followed in consequence.

The history of the struggle of the people of England against arbitrary taxation is the history of the English Constitution. Thus, the attempt to arbitrarily collect an unjust poll tax was the primary cause of the rebellion of Wat Tyler in England in 1378, in the reign of Richard II; as was the "misuse of taxes" the occasion of the rising of the commons of England in the next century (1450) against the government of Henry VI, and under the leadership of Jack Cade.*

Shakespeare, who apparently analyzed and comprehended the subtle philosophy of all human motives and tendencies, seems also in the play of Henry VIII to ascribe the fall of his great minister, Wolsey, to abuse of the power of taxation; and whether

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* Recent historical investigations favor the idea that the leader of this rebellion was not an illiterate rascal and buffoon—one of "the filth and scum of Kent," as portrayed by Shakespeare in Henry VI—but rather a gentleman of gentle and possibly of noble birth.

in this he was historically correct or not, his utterances respecting the effect of such abuse are as pertinent to-day as ever, and in some respects remarkably applicable to the depression that in recent years has come to one great department of the domestic industries of the United States through injudicious taxation of the crude material—wool—that constitutes its foundation:

"The subject's grief
Comes through commissions, which compel from each
The sixth part of his substance, to be levied
Without delay; . . . this makes bold mouths:
Tongues spit their duties out; and it's come to pass,
This tractable obedience is a slave
To each incensed will."
"For, upon these taxations,
The clothiers all, not able to maintain
The many to them 'longing, have put off
The spinsters, carders, fullers, weavers, who,
Unfit for other life, compelled by hunger,
And lack of other means, in desperate manner
Daring the event to the teeth, are all in an uproar,
And Danger serves among them."

The great revolution in England (1642–1659), by which the constitutional rights of her people were finally established, wherein Charles I lost both his crown and his head, was caused by a question of taxation. And subsequently the attempt of Great Britain to tax her American colonies without their consent was also the primary cause of the American Revolution;* while later the demonstrated inability of maintaining a harmonious and efficient government under the Articles of Confederation, which per-

* Recent historical investigations (by Prof. Tyler) have shown that the demand "no taxation without representation," which has been popularly regarded as one of the prime causes that contributed to the revolt of the British American colonies in 1775 and their subsequent independence, "did not mean that the colonies could not be lawfully taxed by Parliament when they had no representatives in Parliament. It was a demand applicable to the three orders of the English body politic—king, lords, and commons—and meant that the commons could not be taxed when they were not represented. But the commons represented the cities of Leeds, Halifax, Manchester, Birmingham, and Liverpool in Parliament, although none of them had any vote or personal representation in it at the time of the American revolt or for a long time afterward. Indeed, only one tenth of the people of the United Kingdom had then any vote. The commons represented Massachusetts in the same way that they represented Manchester. That this was an unsatisfactory kind of representation will be admitted without argument, but it was not in contravention of the maxim quoted, which has come down to us as a legal justification for the war. It would have been strange indeed if the English Constitution had contained within itself a justification for breaking up the British Empire." The separation of the colonies from the mother country was therefore not a legal step, but an act of revolution, and suggests a remark attributed to Mr. Lincoln at the outbreak of our civil war, that "it was a constitutional procedure for overthrowing the Constitution."

mitted the several States that were parties thereto to interfere with their mutual trade and commerce by multiple and conflicting systems of taxation, was one of the principal factors that led to the formation and adoption of the Federal Constitution.

It is also now generally admitted that to the cruel and extraordinary abuse of the power of taxation, more than to any other one agency, is attributable not only the French Revolution, but the extraordinary ferocity with which it was conducted.

No text in the New Testament has been so little understood for want of any recognition of its connection with the subject of taxation, as that one which declares that "it is easier for a camel to go through the eye of a needle than for a rich man to enter into the kingdom of God." By many theologians and secular advocates of social reform—the Russian Tolstoi being a recent notable example of the latter—it has been regarded as a disapproval of the attainment or accumulation of wealth, and has doubtless served as the basis for innumerable sermons on the "sin of riches;" when a little reflection and acquaintance with social economy would have led to the conclusion, as Buckle has clearly expressed it, "that of all the results which are produced among a people by their climate, food, and soil the accumulation of wealth is the most important. For, although the progress of knowledge eventually accelerates the increase of wealth, it is nevertheless certain that in the first formation of society, wealth must accumulate before knowledge can begin, because without wealth there can be no taste or leisure for that acquisition of knowledge on which the progress of civilization depends." And surely a disapproval of this almost self-evident truth could not have been the intent of an inspired teacher. To understand the true meaning of this text it is necessary to go back and consider the time and circumstances under which the declaration it embodies was made. Judea at this period was a subjugated Roman province, and what the wisest and best men of Rome thought of the people of such provinces and of the right of Rome to grind down the nations that it had subjugated, is clearly shown by the following extract from the oration of Cicero against Verres, who was prosecuted for extortion when governor of the province of Sicily: "If," he said, "we have esteemed the revenues of the provinces as the nerves of the republic, we shall not hesitate to say that the order which raises them is the mainstay of the other orders. The provinces and countries subject to tribute are the lands of the Roman people. If Verres is guilty, it is not because of his rapacious exactions, but because he diverted them to his own use rather than to that of the republic." And as for the sufferings of the tributary people, he alludes to them for the necessities of his cause, but he regards them of so little importance that in his oration for Fonteius he

exclaims: "Who are his accusers? Barbarians! Men who wear breeches and smocks! Can the most reputable of the Gauls be placed on a par with the least and most wretched of Roman citizens?" The Romans, in fact, regarded their provinces as valuable only to the extent that they could make them available for extorting tribute (taxes), and the most effective instrumentalities they could employ for this purpose were unpatriotic or renegade citizens of the provinces who understood the habits, pursuits, and amount and distribution of the property of their fellow-countrymen. These in the case of Judea were Romanized or apostate Jews, who, in accordance with the Roman custom, were invested with a power, which they undoubtedly exercised, to administer torture in case it was found necessary to enforce payments from unwilling or impoverished subjects.

Again, as there was little industry at the time save agriculture, and markets were limited, there was little opportunity for a Jew to become rich, except by favor of the Romans and plunder of his people; and with these latter the publican or tax-gatherer and the rich man, who must have been often one and the same, became so abhorrent, that they naturally classified and placed them upon the same plane with notorious sinners and the most despised and degraded members of society—the harlots*—for whom an entrance into the kingdom of heaven was regarded as an impossibility.

And in this connection it is pertinent to recall that Jesus visited the house of "a man named Zaccheus, which was the chief among the publicans, and he was rich." . . . "And when they" (the people) "saw it they all murmured, saying that he was gone to be guest with a man that is a sinner. And Zaccheus stood and said unto the Lord: Behold, Lord, the half of my goods I give to the poor; and if I have taken anything from any man by false accusation, I restore him fourfold." And evidently in consequence of this declaration, "Jesus said unto him, This day is salvation come to this house, forasmuch as he also is a son of Abraham" (and not a foreigner). "For the Son of man is come to seek and to save that which was lost" (i. e., the publicans).

In ancient Greece also there was a familiar proverb that used the term "publican" as synonymous with that of "robber"; and Tacitus, the Roman historian, in his description of the German people, regards them as fortunate in having no publicans to impoverish (*atterit*) them.

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* "Verily, I say unto you, that the publicans and the harlots go into the kingdom of God before you."—*S. Matthew, xxi, 31.*

"For John came unto you and ye believed him not; but the publicans and the harlots believed him."—*S. Matthew, xxi, 32.*

On the other hand, in the case of the Romans, who had little sensitiveness as to the manner in which public revenue or private wealth was attained, the publicans who collected the customs were held in high honor, and were characterized as the flower of the nobility ("*flos equitum Romanorum*").

Another point of interest in connection with this immediate subject, and one which has been generally overlooked, is that the answer which Jesus gave to the Jews, who put to him the question, "Is it lawful to give tribute to Cæsar?"—namely, "Render unto Cæsar the things that are Cæsar's"—expresses a fundamental principle in political economy, in that it enjoins payment on the part of citizens or subjects of such tribute (taxes) as the government (typified by Cæsar) under which they live, may lawfully be entitled to demand for its support; and at the same time withholds sanction from, and so by implication denies, the right of a government to take that to which it is not entitled (or which is not Cæsar's), which it does when it exacts tribute or taxes for any other purpose than its legitimate support, or, what is the same thing, for the benefit of individual or private interests. In other words, the answer recognizes a broad line of distinction between the rights of Cæsar, or the government, and other rights in respect to property; and indicates that Cæsar, or a government, can find no justification, in virtue of power to compel the payment of tribute or taxes, to appropriate property (of the people) under circumstances in which similar action on the part of a private citizen would be considered robbery.

The casual observer would hardly imagine that there was any relation between anthropology (the science of man) and taxation; and yet writers on the laws of nations from an early period, and economists of a later day,* have called attention to the circumstance that different races seem to possess different moral aptitudes for different forms of taxation. Thus it is claimed that in countries inhabited by the pure Germanic race, or its leading branches—in Germany, Scandinavia, Great Britain, and the United States—the desire and ability for self-government, and the disposition to place authority near to the individual or in his town or locality, favors voluntary taxation and a great endurance of burden in view of the attainment of a right result; whereas among the Latin races the tendency is to concentrate all authority, and generally in a military form, in the state, and require passive submission to the exercise of it on the part of the people. Hence, general taxes on property and income, which require for their successful application a certain degree of loyalty, of pa-

* Macchiavelli and other Italian publicists in the seventeenth century, and M. de Parieu, a French economist, in 1855.

tience, and even of voluntary co-operation on the part of taxpayers, and which find favor among the former races, hardly exist among the latter. It is interesting also to note, in connection with this subject, that the restitution to the government of what is termed "conscience money," which is of constant occurrence in Germany, Great Britain, and the United States, is said to be very inconsiderable or wholly lacking in the States of the Latin races.

The comparatively insignificant position which the subject of taxation holds in economic literature has already been pointed out. Its relation to general literature is similar, and perhaps even more remarkable. Since sin came into the world, there has probably been no one purely human agency more prolific of crime and human suffering and of temptation to do wrong than the multitude of arbitrary, impolitic, and absurd laws which have been enacted to unjustly exact from the people contributions of their labor and property under the name of taxation, and yet the utilization of these experiences by novelists and dramatic authors has been almost entirely restricted to the comparatively petty transactions of smugglers and the illicit producers of distilled spirits. Even the terrible tax incidents which preceded and in fact occasioned the great French Revolution, have not entered largely as an element into more than one or two works of fiction of acknowledged merit in the English language.* As a field of morals also, this subject has been almost entirely ignored, and rarely entered upon by theologians; and yet under the tax laws of the United States, to say nothing of other countries, the practice of perjury is encouraged and tolerated to a degree that is utterly inconsistent with the existence of any high standard of public morality, or any rational religious belief.† And so also in the department of history. How few of those who consider themselves well read and well informed, recognize that the terrible decadence

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* The only work of fiction of this character known to the writer is Gabrielle André, by S. Baring-Gould (D. Appleton & Co., New York, 1871), in which the conditions of taxation existing in France, prior to the Revolution of 1788–'89 are instructively used as the basis of a historical story.

† On this topic a leading American clergyman writes as follows: "It is probably a good thing that clergymen have not preached numerous sermons on taxation, even on its moral and religious aspects. That they have hitherto been ignorant on the subject is not so much their fault as their misfortune, and being ignorant on the details of this matter they have not taken it as the theme of set discourses. But, judging by my own experience, they have preached on the application of moral principles to every department of life, and on the obligation of a man to be honest in his dealings with government no less than with individuals. That taxation has moral relations and qualities they have perceived and stated, and that probably was as far as their qualifications authorized them to proceed. Whether the present encyclopedic education will give us the more serviceable clergymen remains to be seen."

of Spain up to 1808 is attributable more to the influence of a tax on sales than to any other one cause; and that, on the other hand, the great wealth and prosperity of Holland in the sixteenth, seventeenth, and eighteenth centuries, and the control of a commerce that made its ships the chief carriers and their ports the chief depots of the products of the world, were due mainly to a system of taxation that imposed the minimum of restriction on exchanges, domestic or foreign, and entailed the least friction upon its own people; while in all other and competitive countries the direct reverse of such a fiscal policy found favor and existed.

THE PLACE OF TAXATION IN HISTORY.—A clear and exhaustive statement of the world's experience in respect to what is called taxation would be almost equivalent to a universal history; and in default of this, a review of the most prominent features of such experience is the only alternative, and is capable of being made in the highest degree interesting and instructive.

While the farthest reach of history touches no period when government or the state has not appropriated for its maintenance or pleasure the property or services of its subjects or citizens, the present ideas respecting taxation are so essentially modern that little or no recognition of them can be found in either ancient or mediæval history. In fact, no taxes, in the present ordinary sense of the term, were needed in ancient times to carry on government or public institutions. The monarch, king, chief, lord, or other sovereign of any particular district or country was generally the owner of all the landed property within his empire or domain; and the people who cultivated it were his villeins, serfs, or tenants. "The theory of English (and also of Chinese) land tenures to-day is, that the original title is in the king or emperor, and that everybody who has an interest in land is a tenant. There is no such thing known to this day in England as an *allodial* title—that is, one which is absolute as to the ownership of the soil, and which is mainly the one recognized in the United States. As a consequence, all land in England is held mediately or immediately of the king, and there is no allodial tenure."*

A sovereign who owned all the land of a country, and could at his will take any portion of the labor products of the people who cultivated or occupied it, obviously was exempt from the necessity of resorting to any other form of levy upon persons or property for the support of the state or for his pleasure; and this

* Miller, on the Constitution of the United States. "Out of this fact come many of the difficulties American students find in regard to the doctrines pertaining to estates and tenancies. Our laws have been freed from a large part of these intricacies and traditional requirements, which were the outgrowth of centuries of development among our English ancestors regarding the holding of land, but their influence still embarrasses our judicial system" (ibid., pp. 231, 232).

mode of appropriating property by the governing power has prevailed in almost every country of the Old World of which we have any fiscal record, at some period of its history. At the same time all history teaches that the actual administration of such governments has been very generally, and perhaps as a rule unnecessarily, oppressive by reason of the manner of collecting or exacting the tribute or contributions from the people, or by the spoliations of the officials to whom the business was intrusted. Throughout the Eastern world the general practice under its native princes has been, and even still is, for the tribute or tax collectors to pay themselves by peculations, and to extort from the cultivator the utmost farthing that could be taken without compelling him to abandon his fields. Thus under the Sikh dynasty of India, which was founded by a petty chieftain on the ruins of the Mogul Empire at the close of the last century and continued until 1846, the custom was to take from the peasant the equivalent of six shillings out of every twelve shillings' value of his produce in the name of rent; but under the present British rule the government takes from the descendants of these same peasants only one or two shillings in the form of taxes. It is not necessary, however, to go to Eastern experiences for illustrations of how the burden of taxation can be made terribly oppressive by the method of taking, inasmuch as in 1598 (according to Sully *), out of one hundred and fifty millions extorted from the taxpayers of France in that year, only thirty millions found their way into the public treasury. It is stated as a not infrequent occurrence that prior to the great Revolution of 1789, a duty was levied twenty-seven times on a barrel of wine in the course of its transportation from the place where it was grown to that where it was sold; so that it was said to be cheaper to send wine from China to France than from one of the departments of France to Paris.

It is also to be noted that in ancient times war, both in Eastern countries and in Europe, was almost the normal state of mankind, and victorious nations supported and enriched themselves from the plunder and tribute of the vanquished. The land especially of subjected people became the property of the conquerors, and payments in the nature of rents rather than taxes were exacted from its occupants and cultivators.

TAXATION IN CHINA.—A curious perpetuation in many respects of these ancient methods is yet to be found in the present system of raising funds for defraying the expenses of the Government in China, and concerning which little has been definitely known until within a very recent period. With the exception of certain limited grants held by Manchu princes in consideration of

* Memoirs of Sully; quoted by McCulloch in Treatise on Taxation, p. 30.

remote military services, all the land of the empire is regarded as the property of the emperor, and all original titles to land are held directly from him subject to three conditions:* *First*, the payment of a land tax; *second*, the payment of fees when the crown title-holder or his successors sell mortgages, or leases; *third*, the supplying of certain labor service when demanded by the authorities. The land tax, which is exacted from all arable land, varies in amount according to the productiveness of the land, and does not ordinarily exceed one twentieth of the gross product. There is no tax on waste and uncultivated land, and rights in common exist in respect to waste land adjoining villages. The fees incident to the alienation of land are *nominally* about three per cent of the purchase money, but usually, by extortion, range from five to six per cent. The supplying of labor, when demanded by the authorities, is not well defined, and is apparently limited to furnishing the Government with transportation and labor on the public works, especially the repairing of dikes and canals. If these conditions are complied with, the state rarely interferes with the possession, alienation, or rental of land by its subjects. When land is rented the Government tax is paid by the landlord, and not by the tenant. The district magistrate is tax assessor, tax collector, judge, and administrator. A board of revenue fixes the amount that each district shall return to the state, and the district magistrate is liable for this sum whether he collects it or not. Any surplus collected, on the other hand, in excess of what is due the state is his private perquisite. Remission of land taxes is made when any great calamities occur, as floods, famines, and fires, and in such cases the tenant has the benefit of three tenths of the remission.

The other chief sources of imperial revenue in China are from a monopoly of salt; from taxes on goods brought through the gates of towns and cities, which appear to be analogous to the European *octroi* taxes; from taxes known as *likin* on the transit of goods through the provinces; from export and import duties, which are of modern origin; and from the sale of honors or titles.† There appear to be no taxes on personal property in China; but in Pekin, and probably in other cities, small license fees are required from certain occupations and manufactures, ostensibly for defraying municipal expenditures.

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* It is even asserted that there is at the present time but one person in all China who holds an absolute freehold title to any real estate, and he in virtue of being a lineal descendant of the Ming dynasty which the Manchus supplanted.

† The *customs* revenue of China for the year 1893 was reported as £3,646,350 (or $18,331,750), of which fully one third was derived from the duties on opium. The average rate of duties on other importations was about six per centum of their entered valuation.

The imperial revenue of China is believed to be about 85,000,000 taels, or $118,750,000, per annum, although the sum actually collected is probably much greater, the part that is unaccounted for being absorbed in the taking by the prominent officials. Under any circumstances, however, the great mass of the people of China are not heavily taxed; and their system of administration has few inquisitorial and annoying features; and to the absence of these the permanency of the Chinese Government for so long a period, and the tranquillity and contentment of the Chinese people may, in a great degree, be attributed. As the chief source of revenue to the state or Imperial Government, furthermore, is the direct and indirect land tax, the existing system of China may be regarded as a living, practical example of the single-tax system.

TAXATION IN JAPAN.—Another example of an ancient system of taxation, which until a recent period has been subjected to very little change, is to be found in the case of Japan. In this country, as in China, the system of taxation is now, as it always has been, essentially a land tax, but greatly modified in recent years to conform to modern conditions. During the feudal period in Japan, taxes were for the most part paid in kind by the cultivators of the soil, and were in fact a form of rent due to the lord of the soil. Under the oldest *régime*, when the emperor was the real as well as the nominal head of the government, the land was divided into nine squares, the central one of which was cultivated by the holders of the other eight, for the use of the emperor, who thus received one ninth part of the total product of the soil. During the fifteenth century, when the military chieftains—the Daimios or Shoguns—had gradually usurped the real power of the emperor, a much larger proportion of the produce of the land was exacted; seldom less than four tenths of the total crop, and sometimes as much as two thirds. The staple food of the country being rice, the taxes were almost invariably collected in that commodity. The amount paid, however, was not fixed by any national measure, but varied from province to province, depending on local customs, the humor of the Daimio, or other circumstances. Moreover, as the established policy of the ancient feudal government was to preserve and fix the status of all classes and conditions of men, it laid down a multitude of vexatious and arbitrary rules regulating every kind of production, which in turn prevented everything in the way of independent action and progress on the part of the producers. Thus, the Japanese farmer without government permission could neither increase nor decrease the amount of his cultivated land; nor could he change from the cultivation of rice requiring a wet or marshy soil to some other agricultural product requiring a drier soil. In short,

all the conditions of land cultivation were so carefully prescribed that the farmer had nothing to do but follow a routine that deviated little from generation to generation. Under such a condition of things, especially under such a system of land tenure and taxation, population obviously could not, and in fact did not, increase either in wealth or numbers; and taken in connection with the circumstance that each of the many daimios or feudal lords maintained great retinues of wholly unproductive retainers, we find an explanation of the fact that Japan continued a poor country with a very slowly increasing population even in times of profound peace. During the century and a quarter from 1721 to 1846, the increase is reported by Japanese authorities to have not been in excess of five per cent.*

After the restoration in 1873 of the authority of the emperor, and the abrogation of the daimio system or lordship, a radical change was made in Japan, not only in the general status of the farmer, but in the conditions, under which he cultivated the soil and paid his taxes. All the previous iron rules imposed upon him were abolished; he was given perfect liberty to buy and sell land or adopt new modes of cultivation. The system of payment in kind to each provincial lord was replaced by a national land tax paid in money. The value of every piece of cultivated land was appraised according to a complex and somewhat arbitrary method of valuation, and on this capitalized value three per cent was imposed, in addition to a Government tax of one per cent for local purposes. In 1876 a decree was issued reducing the general tax to two and a half per cent, and the local tax to one half of one per cent. At the same time, with a view to supplement this reduction of local taxation and increase the national revenues, taxes were imposed on spirits and tobacco, on sales (at varying rates), on contracts, receipts, land transfers, petitions (through the agency of stamps), on some professions and mechanical

* According to a paper read by Prof. Droppers before the Asiatic Society in Tokio, June, 1894, this period was a time of only measurably suppressed anarchy and lawlessness. It was two hundred and fifty years of armed truce. It was one large dance to death. Famines were frequent and dreadful. Having no railroads or steamships, and having, in their eagerness to shut out foreigners and keep in their own people, destroyed all sea-going ships, they had no means of water transportation except by means of wretched junks. Millions upon millions died of hunger. To this day, around the cremation houses of certain inland cities there are acres of heaps of human bones mixed with ashes, the awful witnesses to the might of famine, when hundreds of bodies were burned daily to prevent pestilence. Child murder and exposure were in some provinces so common that the question which neighbors would ask of a father, whether he intended to raise the newborn baby or not, was as proper as it was common. It is estimated by medical men that fifty per cent of the people died of smallpox. Syphilis was almost a national disease. Disease, immorality only partly suppressed, anarchy, famine, social and economical antagonisms, cramped Japan as in bands of iron.

pursuits, and on the ownership and use of ships, boats, and vehicles. The land taxes, however, contribute the largest amount of revenue to the national treasury, furnishing about seventy per cent of its receipts, exclusive of the local land taxes; and in many districts of Japan the total amount yielded by the farmer to the Government, national and local, was estimated in 1891 at even more than fifty per cent of his crop.*

Very curiously, the responsibility for the existence and continuance of this extraordinary system of land taxation in Japan, which finds no parallel in any other country, and the incidence of which constitutes such a burden on the mass of its population, has until a very recent period rested with foreign nations rather than the Japanese Government, and in this wise: When treaties were first made by foreign nations with Japan, after the opening of its ports and the abandonment of its old-time system of non-intercourse with the rest of the world, it was assumed on the part of the former that the Government and people of Japan were in a semi-barbarous condition, and ought to be treated as such in all political and commercial negotiations; and that in respect to trade and commerce the greatest advantage should be taken of the weaker nation that circumstances would permit. The leading nations of Europe and the United States accordingly stipulated, in their treaties with Japan, that it should

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* "This statement, however, gives no indication of the true condition of the Japanese farmer. In this country, where the Government performs so many functions which in America are left to the individual, a high rate of taxation is not necessarily an indication of poverty or of a low standard of living. With a sufficiency of land and a variety of crops, even the Japanese farmer can live comfortably, especially if a good fraction of his land is dry field (*hata*), on which he generally raises two crops a year. Very few of the farmers of Japan, however, are in this condition of tolerable comfort. The amount of the cultivated land of the empire is so small (less than twelve per cent of the whole area) and the population so large (over forty millions) that the land belonging to each family is absurdly insufficient. The average holding is less than two acres, subdivided into smaller parcels, which vary in size in different provinces, but average nearly one eighth of an acre each. Thus, to picture a typical Japanese farm, one must imagine a piece of land less than two acres, cut up into about fourteen pieces, or bits, each separated from the other by a raised path of earth. Even then the picture is incomplete, since the bits belonging to one farmer are not necessarily adjacent to each other, but frequently many a rood apart. Such a beggarly amount of land, even under the most perfect system of cultivation, can not of course yield sufficient to bring up a family according to Western standards of comfort. The idea of wages, or remuneration for labor, scarcely enters the Japanese farmer's mind; he is content if, after paying his taxes, he can in some rough fashion merely make both ends meet. At any fair rate of wages, farming is carried on at a loss in Japan. The farmer seldom eats the rice he grows, generally using barley or millet as a cheaper means of subsistence. His expenditures are on an infinitesimal scale; the clothes of the family are often heirlooms handed down from generation to generation; and as for saving anything from year to year, the practice is so little known in this country as hardly to be considered a virtue."—*Correspondence New York Nation, 1891.*

not impose any duties on exports or imports in excess of five per cent; and the receipts from customs being thus arbitrarily made insignificant, and those from such other sources as spirits, tobacco, licenses, and the like being normally inadequate, the Government of Japan has been compelled to resort to the old feudal system of taxation as the only practical way of obtaining revenue to defray its necessary expenditures.*

But, notwithstanding this, the results that have followed the fall of feudalism in Japan in 1868 are in the highest degree interesting, and constitute an important contribution to the history of civilization. Between 1871 and 1893 the population increased eight millions, railways and steamers have annihilated famine, old epidemics have become rare, the severity of old criminal law has been greatly mitigated, while liberty has encouraged the people to a wonderful activity and progress.

THE SMITHSONIAN INSTITUTION.

PART II. ACTIVITIES OF THE SMITHSONIAN INSTITUTION.

By Prof. HENRY CARRINGTON BOLTON, Ph. D.

IN our first article we attempted to show the circumstances which led to the founding of the Smithsonian Institution, to trace its growth, and to sketch the peculiar field which it occupies. The latter, however, can well be supplemented by a succinct statement of its condition at the present time, or rather in 1895, the date of the most recent Annual Report.

Members of the Institution.—Presiding officer (*ex officio*), the President of the United States; Chancellor, the Chief Justice of the Supreme Court of the United States; the Vice-President of the United States; the Secretary of State; the Secretary of the Treasury; the Secretary of War; the Secretary of the Navy; the Postmaster General; the Attorney General; the Secretary of the Interior; the Secretary of Agriculture; the Secretary of the institution.

Administration.—The business of the institution is managed by a Board of Regents, composed of the Vice-President and the Chief Justice of the United States, three senators, three members of the House of Representatives, and six other eminent persons nominated by a joint resolution of Congress. The Secretary of

* Recent treaties (1894) have in a degree abrogated the disabilities which foreign nations imposed on Japan at the time of the abandonment of its policy of non-intercourse with the rest of the world, but a denial of the right of Japan exclusively to regulate its taxes (duties) on imports is still maintained.

the institution is also secretary of this board and the principal executive officer.

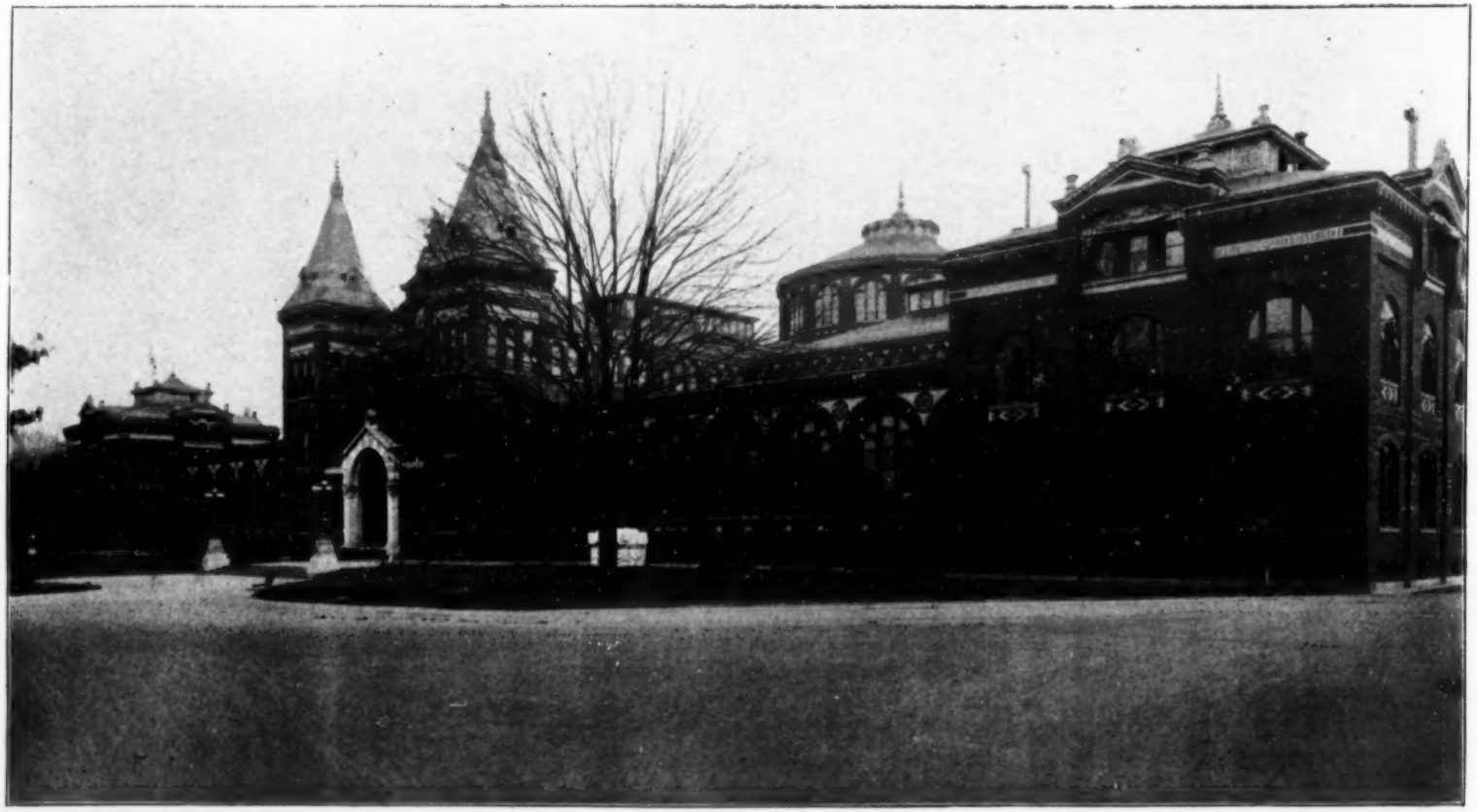
BUILDINGS.—The Smithsonian Institution is housed in two buildings—the Norman, castlelike structure completed in 1855, and the huge one-story museum, to be noted below. The former is occupied as follows: The east wing contains the administration offices, comprising the rooms for the regents, the secretary, the editor, and other officers. A small library of reference books (thirty thousand volumes) occupies a part of the ground floor. The main central hall is filled with valuable collections in ornithology and conchology, including the Isaac Lea cabinet of shells. Above this, another large hall is devoted to prehistoric anthropology. The west wing contains ichthyological specimens, and a very beautiful collection of crustacea, batrachia, and ophidia. In the south porch is a small group of instruments of research.

CORRESPONDENCE.—The official and casual correspondence of the Smithsonian Institution is no insignificant part of its daily life. Letters are addressed to the Secretary by the most learned scholars of Europe as well as by the humblest seeker after truth living in the wilds of North America, and all receive consideration and respectful answers. Tens of thousands of letters are annually received and acknowledged. If inquiries are made which the Secretary and his aids can not immediately answer, the letters are referred to eminent specialists outside of the institution.

The official list of correspondents, embracing learned societies and men of science throughout the world, numbers twenty-four thousand (1894). For a great many years the responsibility of the official correspondence devolved on the chief clerk, Mr. William J. Rhees, who is now keeper of the archives of the institution.

THE INTERNATIONAL EXCHANGE SERVICE.—The Board of Regents in 1851 established a system of international exchanges of the transactions of learned societies and of certain other classes of scientific works. The exchange extends also to specimens in natural history. In 1867 Congress imposed upon the institution the duty of exchanging official documents printed by order of either House, or by the United States Government bureaus, for similar works published by foreign governments.

This international exchange is of the greatest service to learned societies on both sides of the ocean, and to individual men of science who avail themselves of its privileges; it involves a prodigious amount of well-directed labor, as shown by the fact that in the twelve months 1892 to 1893 over one hundred tons of books were handled; these comprised 29,500 packages and 31,850 Government documents *sent out*, besides 101,000 packages and 5,196 Government publications *received*.



United States National Museum.

PUBLICATIONS.—There are three distinct sets of publications issued as serials, directed by the Smithsonian Institution:

1. Smithsonian Contributions to Knowledge, a quarto series begun in 1848, and comprising thirty-two volumes to date. In these volumes are placed the monographs, articles, and papers offering positive additions to human knowledge, either undertaken by agents of the Smithsonian Institution or by persons encouraged by its assistance. These contributions correspond to the more elaborate memoirs of learned societies, and comprise treatises on anthropology, astronomy, biology, chemistry, electricity, ethnology, geology, mathematics, meteorology, natural history, palæontology, physics, and zoölogy, in all their ramifications.

2. Smithsonian Miscellaneous Collections, begun in 1862, thirty-five volumes, octavo. These contain bibliographies, tables, proceedings of Washington societies, and papers on scientific topics of value to scholars, yet not forming, as a rule, positive additions to the sum of human knowledge. These papers vary in size from a leaflet of four pages to a stout volume of twelve hundred pages. The individual articles are first issued independently, each receiving a number in course, and afterward they are bound up in volumes of suitable size, which themselves also bear numbers. This plan of publication also applies to the Contributions. The editorial work of this and the preceding series was long under the care of the late Mr. William B. Taylor, whose great erudition and skill in book-making proved invaluable to the institution.

3. Annual Reports of the Board of Regents—forty-nine volumes, octavo. These are submitted to Congress, in accordance with a clause in the act of incorporation. They contain the Journal of the Proceedings of the Board of Regents, the Report of the Executive Committee, the reports of the Secretary and of the directors, curators, or managers of the important departments controlled by the institution. In these reports are exhibited the financial affairs of the institution, its condition, its operations, and statistics of every kind connected with the same. Following the official part is a General Appendix containing a selection of memoirs of interest to collaborators and correspondents of the institution, teachers, and others engaged in the promotion of knowledge. These essays are generally reprints from divers sources, but they also include original translations and occasionally contributed articles. From 1880 to 1889 this General Appendix was chiefly devoted to an Annual Record of Scientific Progress prepared by specialists.

LIBRARY.—By exchanging the publications of the institution for transactions of learned societies, and for productions of for-

eign scholars, as well as by purchase, a library has been gathered of enormous value, now numbering over three hundred thousand titles. As already stated, it is merged in the Library of Congress, with the exception of a small collection for the use of the officers, partly housed in the Norman building and partly in the Museum. In the magnificent library building now approaching completion on Capitol Hill, the Smithsonian will have a separate hall for its deposit.

THE NATIONAL MUSEUM at first occupied the larger halls in the Norman building, and since 1858 special appropriations have been made by Congress for its maintenance; but, outgrowing its quarters, an independent building was erected by Congressional aid in 1881. This building has an available floor space of one hundred thousand square feet, but has been greatly overcrowded for many years. The director of the museum, who is also Assistant Secretary of the Smithsonian Institution, G. Brown Goode, LL. D., is assisted by thirty-tnree curators in charge of as many departments. These are: arts and industries, embracing twelve sections; materia medica, animal products, naval architecture, fisheries, foods, historical collections, coins and medals, transportation and engineering, Oriental antiquities, graphic arts, forestry, physical apparatus, helminthology, ethnology, American prehistoric pottery, prehistoric anthropology, mammals, birds, birds' eggs, reptiles and batrachians, fishes, vertebrate fossils, mollusks, insects, marine invertebrates, comparative anatomy, invertebrate fossils—paleozoic, mesozoic, and cenozoic—fossil plants, botany, minerals, geology. This mere catalogue of departments shows the prodigious range of subjects, the total number of specimens being more than three and a half millions. Nearly a quarter million of specimens were added in the twelve months ending 1892. The growth of the museum is due to many sources; these comprise the results of exchanges both abroad and at home, explorations by different departments of Government and by the Smithsonian Institution, collections secured through gift of foreign governments, and, most important of all, the collections obtained from several local and international exhibitions, in which the museum has always taken an active part.

An important activity of the museum is its generous distribution of duplicate specimens in natural history to scientific societies, colleges, and other educational institutions throughout the United States. Between 1871 and 1890, two hundred and seventy-eight thousand specimens were so distributed.

The museum is a favorite place of resort on the part of residents in, and visitors to, the Capital. In the year ending June 30, 1893, over three hundred thousand persons availed themselves of its privileges. Their examination of the objects is much

INTERIOR OF THE UNITED STATES NATIONAL MUSEUM.

hampered by the overcrowded state of the building, but it is assisted by the invariable courtesy of those in charge of the sections, and by books of educational value placed in the several departments. It rests with Congress to make an appropriation for erecting another building twice the size of the existing one, and only then will it be possible to display the treasures now stored in dark corners or still resting in unpacked cases.

The publications of the National Museum comprise two series: Proceedings of the National Museum, consisting of short essays giving accounts of recent accessions or newly ascertained facts in natural history, and promptly issued to secure the earliest diffusion of the information. These proceedings were begun in 1878, and are now comprised in seventeen volumes, octavo.

Bulletins of the National Museum, consisting of more elaborate memoirs relative to the collections, such as biological monographs, taxonomic lists, etc., varying in size from a few pages to many hundred pages. The bulletins were begun in 1875 and comprise fifty numbers to date.

THE BUREAU OF AMERICAN ETHNOLOGY was established in 1879, to conduct ethnological researches among North American Indians, and is supported by annual appropriations of Congress. The work is under the immediate direction of Major J. W. Powell, who was also a long time at the head of the United States Geological Survey, assisted by eminent specialists. The bureau conducts mound explorations, studies in ethnology, archæology, pictography, and linguistics of North America. Through its medium a wealth of information concerning the aborigines of North America is being treasured and made available to present scholars and to posterity.

The Bureau publishes four series of works:

1. Annual Reports, begun in 1879, now comprise twelve volumes, royal quarto. This series is handsomely printed and illustrated, and is both creditable to the Government and well adapted to attract public attention.

2. Contributions to North American Ethnology, begun in 1877; nine volumes, quarto.

3. Introductions to the study of various topics; begun in 1877; four volumes, quarto.

4. Bulletins; begun in 1877; twenty-six volumes, quarto.

THE NATIONAL ZOÖLOGICAL PARK.—From a desire to preserve certain American wild animals rapidly becoming extinct, living animals were exhibited in temporary quarters near the National Museum for several years. In 1889 the preliminary steps for the establishment of a Zoölogical Park were taken by the appropriation by Congress of two hundred thousand dollars for the purchase of land, and the park was actually founded by an act

dated April 30, 1890, providing for the "organization, improvement, and maintenance" of a National Zoölogical Park. This act places the park under the direction of the Smithsonian Institution, and orders that it be administered for the advancement of science and the instruction and recreation of the people.

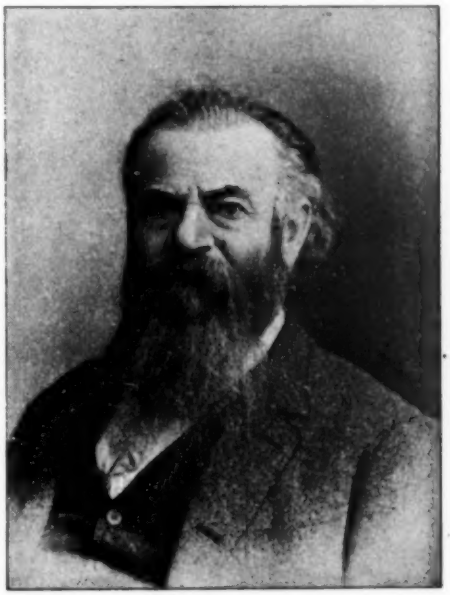
As soon as surveys could be completed, about one hundred and seventy acres of ground most picturesquely situated on Rock Creek, near Washington City, were secured and preparations begun for the reception of animals. This undertaking is so recent that little more has been accomplished than constructing roads, building animal houses, fences, etc., but there are already more than five hundred animals in the embryo Zoo. The natural features of the region, with its watercourses, ravines, rocky cliffs, forest trees, open glades, and sunny southern slopes, are superior to any site occupied in this way abroad or at home, and its extent is ten to fifty times greater than that of most of the gardens of Europe. Under the management of Dr. Frank Baker, the future of the National Zoölogical Park is very great; he plans to place the animals on ground appropriate to their natural habits and instincts, so that they can live under conditions similar to those enjoyed in freedom—a scheme only possible in a park of such great extent and variety of natural features.

G. Brown Goode.

Astro-physical Observatory.—Prof. Baird had begun preparations for the establishment of an observatory for the study of the physical condition of celestial bodies, and when Mr. Langley succeeded to the secretaryship this eminent authority on solar physics soon secured its endowment by Congress. The late Dr. J. H. Kidder bequeathed five thousand dollars for prosecuting physical researches, and Dr. Alexander Graham Bell presented the like sum to the Secretary for the same purpose. In 1889–'90 a temporary wooden building was erected in the Mall south of the Norman building, and, though not entirely suitable for delicate research, much excellent work has been accomplished. In it are placed a

Grubb siderostat, a spectro-bolometer constructed by Grunow & Son, and a galvanometer. These instruments, in the hands of Prof. Langley, are producing remarkable results, considering the inferior building and unsatisfactory site. It is to be hoped that these conditions will speedily be improved through Congressional appropriations.

HODGKINS FUND AND PRIZES.—Previous to the year 1891 the Smithsonian Fund had received only two small additions by gifts or bequests: one thousand dollars from Mr. James Hamilton in 1875, and five hundred dollars from Mr. Simeon Habel in 1880. In the year 1891, however, Mr. Thomas G. Hodgkins, of Setauket, N. Y., made the handsome donation of two hundred thousand dollars to the general fund, with certain conditions. In the formal statement of Mr. Hodgkins, dated September 22, 1891, he used these words: "This fund, to be called the Hodgkins Fund, and all premiums, prizes, grants, or publications made at its cost, are to be designated by this name; the interest of one hundred thousand dollars of this fund to be permanently devoted to the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air, in connection with the welfare of man in his daily life, and in his relations to his Creator, the same to be effected by the offering of prizes, for which competition shall be open to the world, for essays in which important truths regarding the phenomena on which life, health, and human happiness depend shall be embodied, or by such other means as in years to come may appear to the Regents of the Smithsonian Institution calculated to produce the most beneficent results."



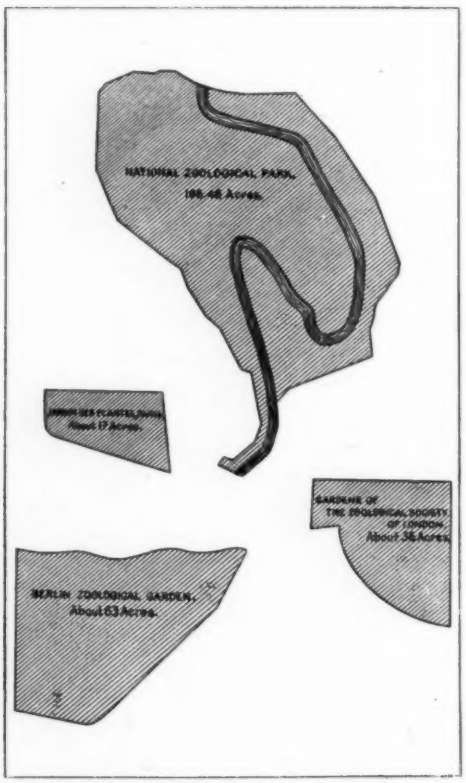
J. W. POWELL.

To carry out the wishes of the donor, the following provisions for prizes, essays, and the Hodgkins medal were adopted by the institution, and announced in a circular issued in March, 1892:

1. A prize of ten thousand dollars for a treatise embodying some new and important discovery in regard to the nature or properties of atmospheric air.

2. A prize of two thousand dollars for the most satisfactory essay upon (*a*) the known properties of atmospheric air, considered in their relationships to research in every department of natural science, and the importance of a study of the atmosphere, considered in view of these relationships; (*b*) the proper direction of future research, in connection with the imperfections of our knowledge of atmospheric air, and of the connections of that knowledge with other sciences.

3. A prize of one thousand dollars for the best popular treatise upon atmospheric air, its properties and relationships (including those to hygiene, physical and mental). This essay need not exceed twenty thousand words in length; it should be written in simple language, and be suitable for publication for popular instruction.



COMPARATIVE AREAS OF ZOÖLOGICAL PARKS.

4. The Hodgkins medal of the Smithsonian Institution will be awarded annually, or biennially, for important contributions to our knowledge of the nature and properties of atmospheric air, or for practical applications of our existing knowledge of them to the welfare of mankind. The medal will be of gold, with a duplicate in silver or bronze.

The treatises may be written in English, French, German, or Italian, and should be sent to the Secretary of the Smithsonian Institution before July 1, 1894; except those in competition for the first prize, which may be delayed until December 31, 1894. The time was subsequently extended to December 31, 1894, for all prizes.

Provision was made in the circular for a committee of award, for extending the dates above named, and for modifying the conditions prescribed. The circular also stated that special grants of money will probably be made to specialists engaged in original investigation upon atmospheric air and its properties.

View in National Zoölogical Park.

In a supplementary circular, issued in April, 1893, it was stated that any branch of natural science may furnish subjects of discussion for the Hodgkins prizes, provided the subjects are related to the study of the atmosphere in connection with the welfare of men: "Thus, the anthropologist may consider the history of man as affected by climate through the atmosphere; the geologist may study in this special connection the crust of the earth, whose constituents and whose form are largely modified by atmospheric influences; the botanist, the atmospheric relations of the life of the plant; the electrician, atmospheric electricity; the mathematician and physicist, problems of aërodynamics in their utilitarian application; and so on through the circle of the natural sciences, both biological and physical, of which there is perhaps not one which is necessarily excluded.

"In explanation of the donor's wishes, which the institution desires scrupulously to observe, it may be added that Mr. Hodgkins illustrated the catholicity of his plan by citing the experiments of Franklin in atmospheric electricity and the work of the late Paul Bert upon the relations of the atmosphere to life as subjects of research which, in his own view, might be properly considered in this relationship."

Eight thousand copies of these circulars were sent to institutions and investigators throughout the world, and applications for grants soon reached the Secretary of the Smithsonian.

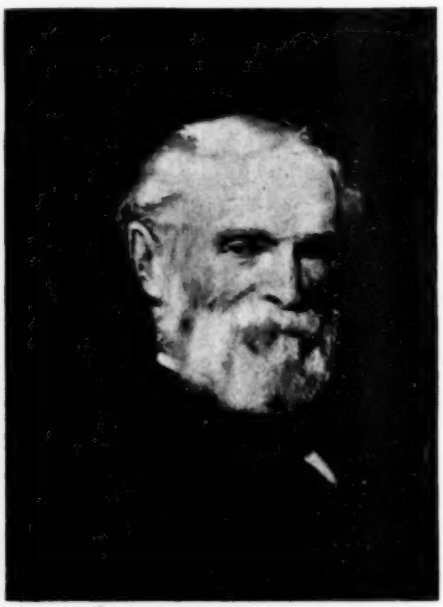
In 1893 two grants were made: one of five hundred dollars to Dr. O. Lummer and Dr. E. Pringsheim, of the Physical Institute, Berlin University, for researches on the determination of an exact measure of the cooling of gases while expanding; and a second grant of one thousand dollars to Dr. J. S. Billings, United States Army, and Dr. Weir Mitchell, of Philadelphia, for investigations into the nature of the peculiar substances of organic origin contained in the air expired by human beings, with specific reference to the ventilation of inhabited rooms.

Mr. Thomas George Hodgkins died November 25, 1892, at the advanced age of nearly ninety years; being, next to Smithson, the most generous benefactor of the institution. A brief sketch of his life is appropriate. He was born in England in 1803, of highly respectable ancestry; his early education was in France, where he acquired language, habits, and manners influencing all his later life. At the age of seventeen, led by a youth's love of adventure, and seeking relief from domestic unhappiness, he shipped before the mast on a trading vessel bound for Calcutta. The vessel was wrecked near the mouth of the Hoogly and the young man found himself penniless, friendless, and ill in a hospital in Calcutta. While in this sad plight, he made up his mind, so he said, to acquire a fortune and to devote it to philanthropic

DEER HOUSE IN NATIONAL ZOÖLOGICAL PARK.

ends. After recovering he returned to England, then visited Spain, and after marrying in England he came to the United States in 1830. He immediately engaged in business and after thirty years of successful ventures he retired on a handsome fortune. The fifteen years following this he spent in traveling over Europe and America, and in 1875 settled on "Brambletye Farm" at Setauket, Long Island, where he led a quiet, retired life.

For more than thirty years Mr. Hodgkins made a special study of the atmosphere in its relation to the well-being of humanity. He believed that this study was important, not only with reference to man's physical health, but even in relation to his moral and spiritual nature, and he hoped that the concentration of thought upon the atmosphere and its study from every point of view would in time lead to results which would justify his almost devout interest in the subject.



THOMAS GEORGE HODGKINS.

Mr. Hodgkins had no family and no known blood relations, and, recognizing the difficulties which often arise over the settlement of large estates, he chose to be his own executor; he therefore gave away his entire wealth to various public institutions; these gifts included large sums to the American Society for the Prevention of Cruelty to Children, and the similarly named society for protecting animals; and one hundred thousand dollars to the Royal Institution of Great Britain.

Since writing the foregoing pages, the Committee of Award for the Hodgkins Prizes has completed its examination of the papers submitted in competition. These papers were two hundred and eighteen in number, and were sent from almost every quarter of the globe. The committee consisted of Prof. S. P. Langley, *ex officio*, Prof. G. Brown Goode, Dr. John S. Billings, Prof. M. W. Harrington, together with a foreign Advisory Committee, composed of the late Prof. T. H. Huxley, M. J. Jansen, and Prof. Wilhelm von Bezold.

On August 6, 1895, the committee announced the following awards:

First Prize, of ten thousand dollars, for a treatise embodying some new and important discoveries in regard to the nature and properties of atmospheric air, to Lord Rayleigh, of London, and Prof. William Ramsay, of the University College, London, for the discovery of argon.

Second Prize, of two thousand dollars, not awarded, owing to the failure of any contestant to comply strictly with the terms of the offer.

Third Prize, of one thousand dollars, to Dr. Henry de Varigny, of Paris, for the best popular treatise upon atmospheric air, its properties and relationships. Dr. de Varigny's essay is entitled L'Air et la Vie.

Besides these capital prizes, three silver medals and six bronze medals, coupled with honorable mention, were awarded to gentlemen for essays of great merit. To name all those awarded honorable mention would occupy more space than at our command.

On November 7th, Lord Rayleigh and Prof. William Ramsay called at the United States embassy, London, and received from the Secretary a check for ten thousand dollars, communicated by the Smithsonian Institution. It was a fortunate circumstance that the Smithsonian had the opportunity of awarding the first prize for so momentous a discovery as that of argon.

FINANCES.—The Annual Report of the Executive Committee of the Board of Regents for the year ending June 30, 1895, gives the following as the financial status of the institution:

Total Funds in 1895.

Bequest of Smithson, 1846	$515,169
Residuary legacy of Smithson, 1867	26,210
Savings from income, 1867	108,620
Bequest of James Hamilton, 1875	1,000
Accumulated interest of the James Hamilton fund, 1895	1,000
Bequest of Simeon Habel, 1880	500
Sale of bonds, 1881	51,000
Gift of Thomas G. Hodgkins, 1891	200,000
Residuary legacy of T. G. Hodgkins, 1894	8,000
	$911,499

Receipts in 1894-'95.

Interest on fund, one year		$54,473
Appropriated by Congress.	International exchanges	17,000
	Bureau of Ethnology	40,000
	National Museum	166,500
	Astro-physical Observatory	9,000
	National Zoölogical Park	50,000
		$336,973

In addition to the above funds the Smithsonian Institution will soon receive the proceeds of a bequest made by the late

Robert Stanton Avery, of Washington City, who died in 1894. The property bequeathed is estimated to be worth about seventy-five thousand dollars, and the income is to be devoted to special investigations in magnetism and electricity.

Finally, the position of the Smithsonian Institution is that of a "ward of the Government, having property of its own for which that Government acts as trustee, leaving its administration wholly with regents." Its most important function is to promote original research, reflecting thus the sentiment which occurs in the writings of James Smithson: "Every man is a valuable member of society who by his observations, researches, and experiments procures knowledge for men." The advancement of utilitarian interests commonly finds capital, for it appeals to the avarice of man; but the advancement of knowledge in its highest and widest sense secures little encouragement from wealthy men, and it is exactly this phase which the institution makes its own. Its next function is to make known to the world knowledge thus secured, for the benefit of mankind, and this it seeks to accomplish through its publications and their wide distribution.

The influence of the institution in local education is well shown by the following circumstance: Some years ago I was standing on the porch of the Norman building as two stout African "ladies" passed by. One of these remarked, "Let us go in there," pointing to the entrance. "Oh, no," replied the lady addressed, "there is nothing in there but 'Prehistoric Anthropology,'" pronouncing the words glibly and accurately. I listened with amazement, and pondered.

THE changes in form which the bookcases underwent in monastic libraries were described by Mr. J. Willis Clark at the recent meeting of the British Royal Archæological Institute. The first form was an elongated lecturn placed at right angles to the wall between the windows, so that readers might have plenty of light to read the books that were chained to it. Splendid isolated examples remain at Lincoln, and a whole library of them at Zutphen. Owing to the large space they occupied, these lecturns were replaced by open bookcases with two shelves on each side. Of this style were the bookcases at Merton College, made in 1365, which served as the model for collegiate libraries in Oxford generally; and it is clear from contemporary documents that like bookcases were in use at Citeaux, Clairvaux, and Canterbury. The modern system of placing shelves against a wall was first adopted at the Escurial in 1584, and was introduced by Wren at Lincoln in 1675. At Trinity College, Cambridge, Wren ingeniously combined the ancient and modern methods by dividing the library into what he termed "cells," or places of study, formed of bookcases against the walls, and others at right angles to them.

THE EFFECT OF PROLONGED DROUGHT UPON ANIMAL LIFE.*

By Dr. CHARLES C. ABBOTT.

FROM July 6 to October 31, 1895, both inclusive, a period of one hundred and eighteen days, there were but seven days when brief showers occurred, no one exceeding one tenth of an inch of rain; and there were four days when prolonged, heavy showers occurred, no one exceeding seven tenths of an inch of rain; and three days, or parts of twenty-four hours, when the fog condensed and for a brief time a drizzle or "Scotch mist" prevailed.

The more prolonged rains occurring September 26th and October 13th caused little brooks, that had been dry for several weeks, to "run" for forty-eight hours, but there was no freshening of the weeds or grass on either upland or meadow. About our dooryards and along the headlands, even where shaded by rank weed growths and the fences, the ordinary grass was brittle, brown, and resting flat upon the earth. Before the beginning of September the landscape had a scorched appearance, this applying also to the foliage of several species of deciduous trees. By this time, too, the last trace of surface moisture had disappeared from the ordinarily wet or "mucky" meadows.

During this time, even at its close, I did not notice any appreciable diminution of the volume of water flowing from the hillside and meadow-surface springs, although I learned that many wells had partly or wholly failed. But, in all cases save one that I examined, the water did not pass over its usual course and join ordinarily permanent brooks, and through them reach the river. The extremely dry ground immediately about the springs absorbed the entire outflow at greater or less distances from their sources. Of course, near the springs there was the usual luxuriance of aquatic and semi-aquatic vegetation, and, what is of interest to the zoölogist, an abnormal abundance or overcrowding of animal life in these oasitic areas.

The continued presence of animal life depends upon the food supply. It is equally evident that no form of animal life can survive for any protracted period an absence of moisture. During the prevalence of the drought heavy dews doubtless afforded a sufficiently copious morning draught to slake the thirst for a period of twenty-four hours, and so met the needs of small mam-

* This article treats of an area of about two thousand acres of upland and meadow in the Delaware River Valley, lying between Trenton and Bordentown, Mercer County, New Jersey.

mals, as mice and shrews, and birds, like sparrows, but ordinarily these same creatures drink much oftener than once a day. But this briefly moist condition of the dawn and early morning hours was not of itself sufficient to keep the wide range of animal life in health or comfort, and the result was a migratory movement from the drier uplands to the moister meadows; a noticeable depletion of the fields and overcrowding of the marshes. This was not suddenly brought about, but rather gradual, and would not probably have been noticed except by one daily upon the scene. The parched vegetation had, of course, its effect upon seed-eating birds, but probably a more marked one upon insect life. Certainly the insect-eating birds left their old haunts to a great extent and were found in unusual abundance along the two creeks that divide the meadows into three great tracts; and it was noticeable during the evening that bats and night hawks were more abundant over the meadows than the fields. Mice and hares certainly were unusually scarce in the uplands. Here, it should be remembered, no observations were practicable that gave positive results. No census could be taken of the life in the two localities, and every statement is one of general impressions gained by almost daily visits to the more important points. One unquestionable fact was ascertained: there was an unusual abundance of life of every kind in the lowlands, and a quiet, desolate condition of the fields above, wholly different from what obtains in ordinary summers. As the weeks rolled by, the smaller meadow streams failed entirely, and hundreds of acres of land, usually more or less wet the year through, became as dry, parched, and desert-like as the sandiest field in the higher ground. Aquatic and semi-aquatic plants withered and died. The rose mallow failed to bloom, arrow-leaf wilted, and the pickerel weeds were soon as brown as sedges. This condition necessitated a second migratory movement of many forms of life, but was fatal to others. Such creatures as took refuge in pools found when too late their means of escape cut off and perished. Small minnows, young salamanders, and even aquatic insects gradually succumbed, and their dried remains were found resting upon the parched mud which became quite hard, sustaining an ordinary foot-press without retaining any mark thereof. Lifting the mummified remains from their resting place, there were found impressions of each, distinct in almost every feature. It was instructive as showing how fossils are formed, and further so, in indicating how animals not associated in life become accumulated in small areas. In one such dried-up pool I found a mouse, a star-nosed mole, and remains of many earthworms, as well as fish, batrachians, and insects. Just why the mouse and mole should have remained there and died can only be surmised. But, to return to the uplands: a more striking

instance of the effects of the drought was to be seen in a small stream known as Pond Run. This is fed by scattered springs; is a stream of perhaps an average depth of six inches and a width of two or three feet. Sudden dashes of rain swell the volume of waters, but this accession is as rapidly run off. In ordinary summers the volume is reduced to considerably below the estimated average measurements, but the stream has not before been known to be absolutely dry throughout its course. For a period of five weeks the water from the springs along its valley were insufficient to give it running water, and in many cases there was no perceptible moisture at the fountain heads. As the water gradually disappeared, that portion of the stream's fauna dependent wholly upon moisture, as fish, turtles, and batrachians, collected in the pools, particularly those beneath bridges, and there by overcrowding soon poisoned the water to which no fresh supply was being added. It might be asked why these animals, except the fish, did not seek other and healthier localities, but the reason is plain. Everywhere about them was an arid region exposed to a tropical temperature into which they did not dare to venture. Again, while lingering in the pest holes into which they had gathered, they had gradually undermined their strength and were too weak to travel when, if ever, it occurred to them to do so.

And now back to the meadows. The last general migratory movement was to the tide-water flats, and here, of course, the moisture and vegetation were unaffected, and I have never seen so crowded a condition as that in which were many of the streams that were never quite dry at even the lowest stage of the tide. The carnivorous fishes waxed fat, for there was an available minnow ever in front of every pike, perch, and bass; and the grasshoppers driven to the creek banks, where alone there was green herbage, were continually leaping into the stream, and were snapped up before they could reach the opposite shore. There was here, however, not such an accession of batrachian life, frogs in particular, as might have been expected, and I failed to notice any undue number of the mud minnow (*Umbra limi*). This fact led me to make a few examinations of the parched or semi-desiccated areas. I found in two locations, that I had never before known to become dry, that frogs, of three species, and the mud minnow had buried themselves where there still remained moisture, but with a crust of dry earth above it. These frogs and fish were like hibernating animals when exhumed—i. e., soundly asleep, rather than dead, and all slowly revived when placed in clear, cool water. I estimated that they had been in their cramped quarters for at least three weeks. Two weeks later, I hunted for others but failed to find them; but the day after the first prolonged rain I found the mud minnows in their usual abundance

in this same brook, which now had about one half its ordinary flow of water, and the frogs were dozing on the banks and leaping into the stream as unconcernedly as if nothing unusual had occurred.

Possibly the above simple narration of certain facts may seem to be of no special interest or importance, but there were two features of it that do not appear to have been treated of in general natural histories: the self-inhumation of the fish and frogs, and the wonderful promptness of the return of life to the temporarily depopulated areas. It does not seem unreasonable to suggest that as long as these inhumed animals could retain their moisture they could preserve their lives. Both the frogs and this one fish can withstand prolonged deprivation of food. I have tried the cruel experiment in one instance, and a mud minnow had no food for seven weeks, and had only lost two fifths of its weight when it died. As this is a period longer than the duration of any drought on record, when fish-sustaining streams were actually dry, it goes to show that this species is better prepared than any other to accommodate itself to certain geological changes when they come about. Curiously enough, the mud minnow looks more like a fossil than an ordinary brook minnow, is the sole representative of its genus, and is the only species of fresh-water fish found in both Europe and America.

While the drought destroyed much life, it more largely deported it, and I have, in many years of wandering about my home, seen nothing more positively wonderful than the promptness with which every nook and corner was repopulated when the autumn rains came. Vegetal as well as animal life responded at once. The fish were promptly in the brooks, the aquatic salamanders under the flat stones, and the frogs in their places, and on many an afternoon of sunny October days I heard their croaking, as if thankful for the return of the old-time conditions.

To a circular of the Royal Society asking for co-operation and suggestions in making a subject catalogue of scientific papers, the Academy of Natural Sciences of Philadelphia has responded that such a catalogue is desirable, and that international co-operation should be engaged in its preparation; that in order to secure uniformity in all parts of such a catalogue a central bureau appears to be necessary, rather than that separate portions should be prepared by various institutions, such central bureau to be under the direction of the Royal Society; that such a catalogue should be classified, and should be issued at least once a year, each volume to be provided with an alphabetical index; that the scope of such a classified catalogue should embrace the various yearly bibliographies of special sciences now issued; and that, whenever translations or summaries are believed to be desirable, English should be made the basis of the catalogue.

GATHERING NAVAL STORES.

By LEE J. VANCE.

THAT portion of the Southern States known as the long-leaf pine belt produces the bulk of all the naval stores used in the world. There is an immense stretch of pine forest beginning in North Carolina near the Virginia border, and it follows along the Atlantic coast to Florida, and along the Gulf coast as far as Texas. This belt of long-leaf pine varies in width from five to one hundred miles, crosses six states—namely, the two Carolinas, Georgia, Alabama, Mississippi, and Louisiana—and covers an area of about one hundred and thirty thousand square miles.

All over this great forest territory the trees are tapped, or "bled," for their sap, which furnishes what are known as naval stores. The work on a "turpentine farm," as a division of the forest is called, begins in winter with the cutting of the "boxes." A broad gash about seven inches deep and fourteen inches long is cut just above the base of the tree, making a kind of box. The cut is V-shaped, slanting from the outside, and thus forms a reservoir, which will hold about three pints of sap.

Meanwhile, the ground around the trees is raked clean, and the pine straw needles are gathered in heaps and usually burned. This is done to protect the boxes from fires, and also to give the "chipper" a firm stand when engaged in his work; but, owing to negligence, small fires are allowed to spread, and often they become disastrous conflagrations, which run over thousands of acres of valuable timber before they are finally checked.

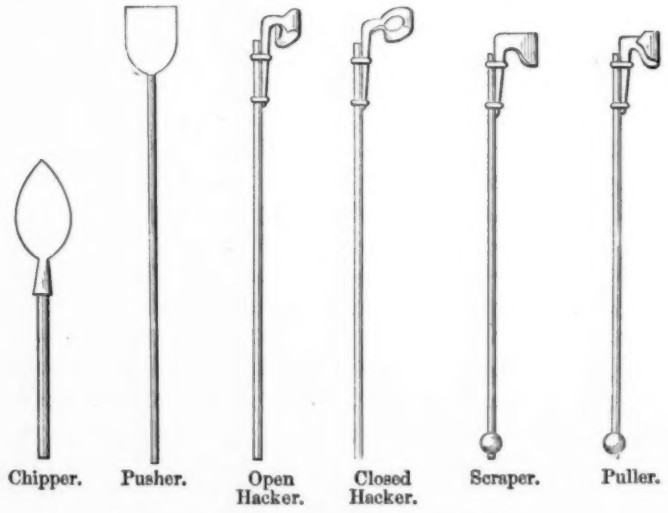
The turpentine season does not really open till early spring, when the sap starts to flow in the trees, and "chipping" begins. The chipper first removes strips about two inches wide, beginning at the corners of the box and extending to a height of about ten inches. Then the surface between the two strips is laid bare to a depth of about one inch beneath the bark.

After a short time the "chip" ceases to "bleed," and then from time to time fresh cuts are made. This is called "hacking," and is done with a peculiar tool called the "hacker." There are two kinds of hackers—the open and the closed hacker. Both are quite similar in shape and size, except that one has an open, strong knife with curved edge, and the other a closed knife blade, fastened to a long iron handle. A heavy weight is attached at the end in order to give momentum to the blows, and it is said to make the work of the chipper easier.

Once a week from March till October the trees are either chipped or hacked. The size of the chip grows at the rate of about two inches a month; so that, by the end of the first season

a surface perhaps fourteen by twenty-four inches is laid bare, and in the fourth and last year the chip has reached a height of six or eight feet.

When the crude turpentine, or resin, begins to harden, it is scraped from the chip and the boxes with a special tool, called the "scraper." The product thus obtained is "scrape," or "hard tur-



TOOLS USED IN THE TURPENTINE INDUSTRY.

pentine." It is of inferior quality, containing only about one half of the volatile oil obtained from "dip," or soft turpentine. In the first year the tree yields four times as much dip as scrape, but in the fourth year the amounts are about equal.

The flow of turpentine is influenced by the state of the weather, especially the temperature. A long spell of heat or a long spell of cold decreases the yield. The flow is greatest during the hot summer months, July and August; after that it becomes less and less till October or November, when it ceases. Last year (1895) the turpentine crop was a poor one, on account of the cold spring.

The resin which accumulates in the boxes is removed by a trowel-shaped dipper. The operation is known as "dipping." In the first year from six to eight dippings are made. The dip is put in barrels and taken to the "still," where it is transformed into spirits of turpentine, resin or rosin, and pitch. Tar is made by burning the dead wood or limbs in kilns.

The crude turpentine in its natural state as it flows from the tree during the first year is distinguished by its fine white color. During the latter part of the season it shows a faint straw tint. The product dipped in the first part of the season is "virgin dip,"

and the other is "second virgin dip." It is from these virgin dippings that the best and highest-priced grades of resin are obtained.

In the following years the turpentine is known as "yellow dip," and it becomes darker colored, less transparent, and less liquid every year. In the fourth and last year the turpentine is very dark in color, and yields resin or rosin of the lowest grades, ranging from a deep brown to almost black and opaque.

If you look at the market reports, under the heading of Naval Stores, you will find certain technical terms and mysterious letters. The letters designate the different grades of rosin, as follows: W G, window glass; W W, water white, the lightest grade; N, extra pale; M, pale; K, low pale; I, good No. 1; H, No. 1; F, good No. 2; E, No. 2; D, good strain; C, strain; B, common strain; A, black.

Besides you will find a number of terms peculiar to the turpentine industry. Down South you hear the natives speak of the

Beginning the Work in a Virgin Forest: Boxing.

great pine forests as "turpentine farms," although some people refer to them as "turpentine orchards." The word "crop" has a special meaning. When a turpentine farmer speaks of his crop he means ten thousand boxes. This will be about five thousand trees, as from two to four boxes are cut in full-grown trees.

There will be about that number of trees on an area of two hundred acres.

Most of the turpentine farms are worked by operators on a large scale. Small landowners can not afford to work their trees, and so they rent or lease their forests for four years at the rate of fifty dollars per crop of ten thousand boxes. The total expense of working one crop is about six hundred dollars per year, or twenty-four hundred dollars for four years. Few operators work less than ten crops, which would make their expenditures twenty-four thousand dollars during the four years. To this should be added the cost of a plant (about four thousand dollars) for working ten or twenty crops, establishing a still, building houses and sheds, and buying tools, mules, and horses.

The amount of product gathered from a crop of two hundred acres in the first year is about two hundred and eighty barrels of dip and seventy barrels of scrape. This yields at the still about two thousand gallons of spirits of turpentine and two hundred and sixty barrels of rosin. In the fourth and last year the yield of the crop falls to about one thousand gallons of spirits and one hundred and ten barrels of rosin.

In speaking of the profits of the turpentine industry a veteran operator said: "There is no money in the business nowadays. Prices are too low. With the spirits at twenty-seven cents per gallon and resin at a dollar and twenty cents, it takes a right smart man to make much more than one dollar per acre."

The prices of all kinds of naval stores reached their highest point during the late war, when spirits of turpentine sold for a dollar and fifty cents and a dollar and seventy-five cents per gallon, and inferior grades of rosin sold for four dollars a barrel. This gave a "boom" to the turpentine industry of France, as production in the South was practically checked for several years.

Next to the work in the pine forest, the operations at the still are interesting. Here, by the process of distillation, are obtained the different resinous products of trade, which go under the name of "naval stores." The term seems to be a misnomer just now when ships are built of iron and steel. About nine tenths of all the naval stores are used in industries other than shipbuilding.*

If you go into a turpentine still when it is in operation you will see how much care is taken to obtain the naval stores. You will inhale the health-giving properties of the pine-tree sap. Your nostrils are tickled by the pungent odor of the boiling turpentine; there is something strong and stimulating about the smell. Your lungs seem to swell to twice their normal size, and, as one person

* Oddly enough, the term "naval stores" is not defined in Webster, Worcester, or the Century dictionaries.

said to me after a visit to a still, "I feel braced up." There is no better sanitarium than the pineries of the South, and the turpentine workers are as strong and healthy a set of fellows as you can find anywhere.

The manner in which naval stores are obtained may be briefly described as follows: The dip, or crude turpentine, is emptied into a big copper still and boiled. The steam is passed through a "worm"—a coil of pipe similar to that used in a liquor distillery

SCRAPING AND DIPPING IN A TURPENTINE ORCHARD.
Tree to the right shows scarified surface.

—and on reaching a certain point the condensation drops into a tank, and is the spirits of turpentine of commerce.

The residuum left after the spirit of turpentine has distilled over is the rosin of trade. This is drawn off by a tap at the bottom of the still, and strained first through a wire cloth and then through a coarse cotton cloth, and run into a trough, from which it is ladled into barrels.

In the several turpentine States, so called, there are laws regulating the inspection of turpentine, defining its grades, the size and kind of barrel, and the manner of branding. The chief points of these regulations, which are more or less the same in the several Southern States, are: turpentine must be branded "S," or "H," for soft or hard; the soft turpentine barrels to weigh two

hundred and eighty pounds, the hard turpentine two hundred and forty pounds, and pitch, thirty-two gallons to the barrel. All spirits of turpentine are gauged by the inspectors of naval stores. Tar and turpentine barrels are marked and certified, and usually show the initials of the maker's name.

Very few people have any correct notion of the number of uses to which the products of turpentine have been put. Let us mention some of the different ways spirits of turpentine enters into the arts and manufactures. Many who read this article by gaslight will remember when they read their newspapers by the smoky light furnished by "camphene." This was before the introduction and use of petroleum. Camphene is prepared by mixing the rectified oil of turpentine with alcohol. Although kerosene is now so cheap, the rectified spirits of turpentine is still used for illuminating purposes in some backwood sections of the South.

Perhaps the most common uses of the spirits of turpentine are those in the arts, where it enters into the preparation of paints and varnishes, and especially in the manufacture of India-rubber goods. The paint and varnish industries take about five million gallons annually, while the rubber industry requires about three and a half million gallons a year.

But spirits of turpentine has other uses not so well known to most readers. How many would enjoy their salad oils and other vegetable oils, if they knew that they were adulterated with turpentine oil? How many invalids know that their medicines contain spirits of turpentine, or that the liniment or ointment which relieves their aches and pains is largely composed of turpentine?

Quite as varied and valuable are the products of rosin in the arts and manufactures. Do you know that the finest grades of rosin are used in the manufacture of paper? How many persons who look at the printer's ink on this paper would say that it contains rosin? How many, washing their face and hands, ever suspect that there is rosin in the scented soap? There is rosin in all these products, as there is in sealing wax, putty and sizing, and in varnishes.

Two kinds of rosin oil are obtained from rosin by the process of dry distillation. The light rosin oil is used principally in the fine varnishes. The heavy oil enters into the manufacture of axle grease, and machine and lubricating oils. It is one of the best and cheapest lubricants for metal bearings in machinery, the petroleum oils not excepted. The heavy rosin oils are largely used in the preparation of cheap paints, such as are used to cover metal, roofs, and so forth.

The product called "pitch" is the residue from the dry distil-

lation of rosin. It is used for the calking of ships, shoemaker's pitch, and black dyes or pigments. There is a special kind of pitch used by brewers for pitching beer kegs and barrels. The process of distillation requires experience and care in order to obtain the right quantity of oil of turpentine; if too little oil, the pitch is brittle and does not adhere to the barrel; if too much, it gives a sharp, disagreeable taste to the beer.

North Carolina for years produced nearly all the tar used at home and abroad, and from this fact its people were called "tar-heels." Wilmington, N. C., is the headquarters for tar and crude turpentine, but Savannah, Ga., is the largest market in the world for naval stores. The process of making tar is simple, and may be briefly described as follows: The dead limbs and wood are put in a heap in a hole in the ground and covered with dirt and sod. A fire is started at the bottom and allowed to smolder for eight or ten days, when the tar begins to flow. It is then dipped into barrels, which contain three hundred and twenty pounds net. About forty gallons of tar are obtained from one cord of wood.

The best grades of charcoal are now made from the pine-tree wood and bark. The sawdust carries a heavy percentage of wood alcohol and creosote. The product known as oil of tar is obtained by dry distillation of the tar, and is used by farmers and fruit-growers as an insecticide, and by doctors and veterinary surgeons for external applications.

Such, then, are some of the important ways in which turpentine enters into the industries, supplying man's needs and wants. The Chinese used to say that the cocoanut palm had as many good uses as there are days in the month. The same and even more can be said of the long-leaf pine. This wonderful tree is almost like cotton in the variety and value of its products.

It is perhaps not generally known that matting and excelsior are made from the pine trees. There is a factory about fifteen miles from Wilmington that uses the pine straw as material for bagging to cover the cotton bales. When the duties on jute and jute bagging were increased, this material was in large demand.

In addition to its other uses, the long-leaf pine belt furnishes annually an immense quantity of timber to the markets. Georgia "yellow pine," as it is called, is known the world over. It is one of the most durable and ornamental of woods. It is light and easily worked, and yet it is tougher than many woods twice its specific gravity. It holds paint and varnish better than most woods, owing to its resinous qualities, and, having a finely marked grain, it shows off well when highly polished. It is thus taking the place of hard woods for use in the building of railway cars, in furnishings for offices, and for interior work in houses. It stands

TURPENTINE STILL AT MANLY, N. C.

the weather, rain and sun and storm, and wears as well outdoors as inside.

Here is the place to state that, until recently, architects, builders, and engineers had a prejudice against using pine timber that had been bled of its sap for turpentine. They claimed that the bleeding process weakened the tensile strength of the timber. This was disputed, of course, in the South. In order to settle this important question, as the yellow pine lumber industry had grown to enormous proportions, the National Bureau of Forestry undertook a series of careful tests three or four years ago. It was shown by experiments that the sap comes from the sapwood, leaving the heartwood unaffected, and hence the prejudice against bled timber is not founded in fact or reason; in other words, after the pine wood has been tapped, its tensile strength, according to these tests, remains equal to that of virgin growth.

The value of the naval stores produced in the United States is about ten million dollars per annum. Nine tenths of all the naval stores used in the world come from the pineries of the Southern States. The other one tenth is furnished principally by the forests of France and Austria.

The most careful figures of the total production of naval stores in the United States are those gathered by the special agent of the Division of Forestry for the year 1890. They show the total production of these stores to be three hundred and forty thousand casks, or seventeen million gallons of spirits of turpentine, and one million four hundred and ninety thousand barrels of resin of different grades.

In order to produce this amount of naval stores it is estimated that about two million three hundred thousand acres are being worked, and that about eight hundred thousand acres of virgin forest are invaded every year to supply the turpentine stills. At this rate it will not be many years before the effects of reckless cutting, sapping of timber, and fires will be felt in the long-leaf pine belt. As a matter of fact, there has been a steady decline in the production of naval stores during the past ten years in every Southern State except Georgia, and there the increase has been due to the opening of new tracts of timber made accessible to shipping points and markets by railroads.

There is no doubt that the American process of bleeding the pine trees is crude and wasteful, and that the turpentine workers, like the lumbermen, conduct their operations on what has been bluntly termed "the robbing system." What else is it but robbing, when the turpentine operators strip the land of its forest resources, and leave only desolate wastes? It is now time that our turpentine workers introduced better methods and necessary changes in their business.

Thus, it is interesting to note the care and economy with which turpentine farming is carried on in France. There, trees are known to have been boxed and bled for a full century, whereas in the Southern States trees are seldom worked for more than five or six years. The differences between French and American practices may be briefly stated, as follows:

The French turpentine workman does not cut a big, deep, broad box into the tree. Instead, he makes a small chip about three inches wide, an inch and a half high, and only two fifths of an inch deep, near the foot of the tree. This chip is enlarged from time to time, and at the end of the first season it reaches a height of about six feet. During the next four seasons the chipping increases at the rate of about two feet and a half each season, so that at the end of the fifth year the chip reaches a height of twelve or thirteen feet. Only one chip is made on a tree at a time. A tree that has been worked for five seasons is given a rest of several years, and then a new chip is started some six or eight inches from the old one. And so, by alternating periods of bleeding and of rest, trees fifty years old and more will be completely encircled by long scars or chips, and when the trees cease to yield a profitable supply of turpentine they are bled "to death" and cut into lumber.*

The French method of collecting the sap is better and more economical than ours. Instead of having the resin or crude turpentine run into a deep box at the base of the tree, as in this country, the French gather the crude turpentine in a pot or pail, which is nailed just above the old chip. As the sap flows only a short distance, there is not much loss from evaporation, and, besides, the product is cleaner. The chip is covered with a board, and this simple device assures a good yield and a clean product. It is claimed that by the French or Hugues system the yield of turpentine is one fourth larger than by the American method, and the trouble of securing comparatively pure sap is more than repaid by the increased price.

In brief, the French methods of collecting turpentine should be an "object lesson" to our Southern orchardists, who carry on their business in a most wasteful and extravagant manner. The result is, if the same care and economy which are observed in the pineries of France were taken of the pine forests of the Southern States, they would yield an annual revenue second only to that of the cotton crop. If to the naval stores be added the amount

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* The method of boxing trees during their productive period is known as *gemmage à vie*—i. e., "bleeding alive"; the "bleeding to death," *gemmage à morte*, is commenced when the turpentine orchard needs regenerating. By this method of forest management the trees are kept uniform, strong, and in good shape or condition.

THE FRENCH METHOD OF BLEEDING THE TREES.

of lumber that can be taken from the pine belt, we have a revenue even larger than that of the cotton crop. All this could be done without reducing the forests of the South to any serious extent. It simply requires good husbandry and common sense in forest management.*

Perhaps the greatest loss and damage are caused by fires, which sweep through the forests and destroy millions of feet of valuable timber every year. It is estimated that the total loss from this source alone is not less than a million dollars annually.

The greater part of this loss of valuable timber is wholly unnecessary. Our people take extra precautions against allowing fires to burn their houses and buildings, but they view with comparative indifference the destruction of millions of feet of timber. The districts invaded by the turpentine workers are left desolate wastes, and few people who have not been in the long-leaf pine belt can realize the great injury that has been done to the prosperity of the South by an industry which is rapidly changing the face of Nature and even the climate of the country.

THE STUDY OF INHERITANCE.

A Review of the Writings of Francis Galton.

By W. K. BROOKS, LL. D.

FIRST PAPER.

IT is much more easy to talk about inheritance than to study it. Of the books and essays which meet us at every turn, few have much basis in research, but those of Francis Galton are among the most notable exceptions. These books, which have appeared at intervals during the last twenty-five years, are not speculations but studies. They describe long exhaustive investigations, carried out by rigorous methods, along lines laid down on a plan which has been matured with great care and forethought.

The simplicity of their language is as notable as their subject. Dealing with conceptions which are both new and abstruse, the author finds our mother tongue rich enough for his purpose, and, while the reasoning often taxes all our powers, there is never any doubt as to the meaning of the words.

When in rare cases a technical term is inevitable, some famil-

* Three years ago the Geological Survey of North Carolina investigated the methods of the turpentine industry and suggested a number of radical changes or improvements. The recommendations have been adopted by many turpentine workers, who have modified their old, destructive methods. Prof. J. A. Holmes, of the Survey, informs me that as a result of these improvements the production of naval stores in North Carolina has been increased by one hundred and fifty thousand dollars within the past two years.

iar word is chosen with so much aptness that it does its duty and presents the new conception better than a compound from two or three dead languages. The terms "mid-parent" or "mid," "fraternity," "nurture," and "Q" can not mislead or convey any idea except the right one.

The reviewer's debt to Galton is very great, and it is acknowledged with gratitude. Such acquaintance with the statistical method as he possesses he owes to the study of these books; especially the ones on Hereditary Genius (1869), on Natural Inheritance (1889), and on Finger Prints (1892).

The attempt to question Galton's generalizations may therefore seem ungracious and presumptuous, but the uncertainties of vital statistics are proverbial; and it is not impossible that Galton's data may fail to cover all the ground needed to prove his general conclusions.

One of these generalizations is so far-reaching that, if it is well founded, it must lead to profound and fundamental changes in our view of the origin of species.

According to Darwin and Wallace, specific identity in living things is the outcome of the extermination, in the struggle for existence, of the individuals which depart too widely from that "type" which is on the whole best adapted to existing conditions. As these conditions change, the "type" is also slowly modified through a change in the character of this process of extermination. According to this view, the "type" is the outcome of the statistical "law of error," or the deviation from the mean, which holds good in the environment; and while the "events" are properties of the organism, the type is fixed by the external world, and not by anything in the organism itself.

Galton holds that specific identity is not due to the process of extermination, but to "organic stability." As I understand him, he holds that this fills up the gaps made by extermination, and thus keeps the type intact.

This "principle of stability," which is held to result in the permanency of types, is said to be quite independent of selection. "Genera and species may be formed without the slightest aid from either natural or sexual selection." "Organic stability is the primary factor by which the distinctions between genera are maintained."

Galton holds, furthermore, not only that specific stability is independent of selection, but that selection is "scarcely competent" to effect a change of type "by favoring mere varieties"—that is, by the extermination of the ordinary slight differences between individuals; and that it is only when a "sport" has made its appearance, only when the type has actually changed, that selection can exert any influence. According to this view, the

agencies which cause "sports" are the real causes of the mutability of species, and natural selection can do nothing more than to exterminate disadvantageous sports, and thus favor advantageous ones.

The "organic stability" to which so much is attributed is held to be due to the fact that the child inherits in part from its parents, in part from more remote ancestors; and since the sum of its ancestry, or its "mid-parentage," is on the average nearer than any exceptional parents to the mean of the race, the children of selected parents are on the average more mediocre than their parents.

It is quite possible that Galton's data may be valuable and trustworthy, and that they may yet fail to prove this generalization; and I shall try to show that this is the case, although I am not sure that I fully grasp his point of view.

I assume that he regards a zoölogical type or species as something; something which is due to a "principle of stability," which is not the result of selection. This is assuredly the current interpretation of his statements, and it is from this standpoint that I shall examine his writings.

If this is not his opinion; if he really believes that this "principle" owes its existence to past selection; if he only deduces from his data the generalization that the results of past selection may persist after it has ceased to act; I see no ground for criticism, for his data assuredly prove this much, although I can not reconcile his statement that "the principle of stability is independent of selection" with the belief that it is the result of past selection.

Before entering upon the discussion of the subject it may be well to ask what evidence there is that the child does inherit from any ancestor except its parents, for descent from a long line of ancestors is not necessarily equivalent to inheritance from them, and it is quite possible that the conception of a "mid-parent" may be nothing but a logical abstraction.

Most of its support is derived from the phenomena of reversion or atavism; from the appearance in children of ancestral features which were not exhibited by the parents. While these phenomena are familiar and real, we may well doubt whether any of them are reversions in Galton's sense.

In some cases we can prove that a so-called reversion is simply the manifestation of a feature which is latent in the structure of all the normal individuals of the species. The occurrence of a distinct premaxillary bone in man is an example of this sort of reversion. It is the outcome of the arrest of normal development, and this arrest might have happened to any member of the species. We do not know what causes the

arrest, but the view that it is due to some adverse circumstance which has kept the individual from completing its development is much more simple and probable than the view that the child inherits its distinct premaxilla from any ancestor except its parents.

When the son of a beardless boy grows up and acquires a beard, we may be permitted to say that he has inherited his grandfather's beard; but this is only a figure of speech, and he actually inherits the beard which his father might have acquired had he lived; nor would the case of a child descended from a series of ten or a hundred beardless boys and beardless women be any different. If we were to propagate a plant by cuttings, for ten or a hundred generations, under conditions which did not permit it to flower, and were finally to put the last of the series where it did flower, we should not be justified in saying that it did not inherit its flower from the preceding cutting; nor would the case be any different if, for some reason, this preceding cutting could not be made to bloom.

The phenomena of polymorphism in insects and in hydroids present illustrations of the normal inheritance of latent characters, but we find in them no ground for the assertion that the ancestral characteristics of the medusa are not inherited from the hydroid which produces it.

The sum of the visible features of the parent, plus the sum of its latent potencies, may be called a "mid-parent" for statistical purposes, if we see fit, but there is no evidence that this mid-parent is anything else than the actual parent.

With this introductory note, we may now enter upon the study of Galton's works, the central point of which is as follows:

If we select any one characteristic of a natural group of animals—such a characteristic as the weight of the individuals, or the ratio between the lengths of their arms and legs, or anything else which admits of exact numerical statement—it will be found that while no two members of the group are exactly alike, they nevertheless conform to a type, and show the existence of a standard, the mean or average, to which the majority adhere pretty closely, while other members of the group are more abnormal, and show marked deviation from the mean.

If the cases tabulated are numerous enough, the individuals will conform, so far as this quality is concerned, to what is known in statistical science as the law of frequency of error. This agreement will be so close, when great numbers of instances are examined, that the number of individuals which depart from the mean to any specified degree may be computed mathematically.

For example, the chest measurements of 5,738 soldiers gave the following results:

Inches.	Measured.	Computed.
33	5	7
34	31	29
35	141	110
36	322	323
37	732	732
38	1,305	1,333
39	1,867	1,838
40	1,882	1,987
41	1,628	1,675
42	1,148	1,096
43	645	560
44	160	221
45	87	69
46	38	16
47	7	3
48	2	1

If the number of events had been five hundred thousand or five million instead of five thousand, the agreement between the computed and observed frequency of each degree of departure from the mean would have been very much closer. When the number of cases is unlimited, the agreement is perfect.

Galton gives the following illustration of the significance of a type:

Suppose a large island inhabited by a single race, who intermarry freely, and who have lived for many generations under constant conditions, then the average *height* of the adult male of that population will undoubtedly be the same year after year. Also—still arguing from the experience of modern statistics, which are found to give constant results in far less carefully guarded examples—we should undoubtedly find year after year the same proportion maintained between the number of men of different heights. I mean if the average stature was found to be sixty-six inches, and if it was also found in any one year that one hundred per million exceeded seventy-eight inches, the same proportion of one hundred per million would be closely maintained in all other years.

An equal constancy of proportion would be maintained between any other limits of height we please to specify, as between seventy-one and seventy-two inches, between seventy-two and seventy-three, and so on. Now, at this point the law of deviation from an average steps in. It shows that the number per million, whose heights range between seventy-one and seventy-two inches, or between any other limits we please to name, could be *predicted* from the previous datum of the average, and of any other one fact, such as that of one hundred per million exceeding seventy-eight inches.

Suppose a million of the men to stand in turns with their backs against a vertical board of sufficient height, and their heights to be dotted off upon it. The line of average height is that which divides the dots into two equal parts, and stands, in the case we have assumed, at the height of sixty-six inches. The dots will be found to be ranged so symmetrically on either side of the line of average that the lower half of the board will be almost

a precise reflection of the upper. Next, let a hundred dots be counted from above downward, and let a line be drawn below them. According to the conditions, this line will stand at the height of seventy-eight inches. Using the data afforded by these two lines, it is possible by the help of the law of deviation from an average to reproduce with extraordinary closeness the entire system of dots on the board.

This law of deviation from an average is not restricted to vital phenomena, but holds true of all events which are the resultants of variable conditions, which remain the same through all the events recorded. If the marks on the board had been made by bullets fired at a horizontal line stretched in front of a target, they would have been distributed according to the same law, their average value would be constant, and the deviations of the several events from the average would be governed by the same law, which is identical with that which governs runs of luck at a gaming table.

Galton has described an apparatus which mimics in a very pretty way the conditions on which deviations from a mean depend. It is a long, shallow box set on end and glazed in front, leaving a depth of about a quarter of an inch behind the glass. Strips are placed in the upper part to act as a funnel. Below the outlet of the funnel stand a succession of rows of pins stuck squarely into the backboard, and below these again are a series of vertical compartments. A charge of small shot is inclosed. When the frame is held topsy-turvy, all the shot runs to the upper end; then when it is turned back into its working position the desired action commences.

The shot passes through the funnel and, issuing from its narrow end, scampers deviously down through the pins in a curious and interesting way: each one of them darting a step to the right or left, as the case may be, every time it strikes a pin. The pins are so placed that every descending shot strikes a pin in each successive row. The cascade issuing from the funnel broadens as it descends, and at length every shot finds itself caught in a compartment immediately after freeing itself from the last row of pins. The outline of the columns of shot that accumulate in the successive compartments approximates to the mathematical law of frequency, and is closely of the same shape, however often the experiment is repeated.

The outlines of the columns would become more nearly identical with the normal law of frequency if the rows of pins were much more numerous, the shot smaller, and the compartments narrower; also, if a larger quantity of shot were used.

The principle on which the action of the apparatus depends is that a number of small and independent accidents befall each

shot in its career. In rare cases a long run of luck continues to favor the course of a particular shot toward either outside place, but in the large majority of instances the number of accidents that cause deviation to the right balance in a greater or less degree those that cause deviation to the left. Therefore most of the shot finds its way into the compartments that are situated near to a perpendicular line drawn from the outlet of the funnel, and the frequency with which shots stray to different distances to the right and left of that line diminishes in a much faster ratio than these distances increase.

Types which are based upon vital statistics have peculiar interest, since they persist from generation to generation, according to what is known as the law of specific stability, while they also undergo slow changes according to the principle of the mutability of species.

Individuals come and go, but the type persists, and its slow changes may be pictured as quite independent of and more substantial than the procession of individuals which files past only to vanish from the world.

The statistical comparison of vital types affords a means for studying the phenomena of inheritance by the exact methods of mathematics, and it is capable of yielding definite and valuable results, so far as the vital phenomena which are studied can be treated as if they stood alone, but the attempt to generalize from vital statistics and to deduce general laws of inheritance from them is attended by peculiar difficulties, due in great part to the fact that the data which are studied are not separable from the organism which exhibits them. Stature or size or weight may be treated abstractly for statistical purposes, but the stature of an organism is not an abstraction, for the organism is not only a bundle of properties, but a unit as well, and its stature is only one among many features which are all beautifully co-ordinated with each other in such a way as to promote the welfare of the species. A generalization which ignores this fact and treats stature as an abstraction may, while proved by statistics, be untrustworthy as a contribution to our knowledge of inheritance.

In popular language, specific stability may be said to be due to inheritance, and specific mutability to variation; but in this connection these words have only a loose meaning. In so far as they convey the impression that the stability of species and the mutability of species are antagonistic to each other, or are due to two distinct and opposing influences, these terms are unfortunate, for we have good ground for holding that they are due to the same influence—the extermination of certain individual peculiarities, and the preservation of others by natural selection.

The older naturalists held that adherence to type is due to

some innate principle of specific stability which is an essential and immutable attribute of each species of living things; but the accumulation of conclusive evidence of the mutability of species has driven this conception out of the field. Most naturalists now regard the type as nothing but that normal which is most perfectly fitted to the environment, and they hold that it is kept true through the extinction of aberrant individuals by selection.

According to this view, which seems to be supported by ample evidence, the stability of species is due to survival—to the same mechanism which brings about the mutability of species.

Galton is led by his statistical studies of vital characters to a view which bears an odd resemblance to that of the older naturalists; for, according to him, the principle of stability which results in the permanency of types is quite independent of selection.

He shows, for example, by the statistical study of stature, that the type of human stature is very constant from generation to generation, although the statistics of marriage show that there is no controlling tendency for persons of like stature to marry. He also shows that the children of parents who are both tall or both short do not on the average have the stature of their parents, but are nearer than they to the mean for the race. These facts, and others like them, are held to prove the existence of a principle of stability independent of selection.

In his more recent work on the patterns at the tips of human fingers, he says that—since it has been shown (chapter xii) that the character of the finger prints is practically identical in Englishmen, Welshmen, Jews, negroes, and Basques, the same familiar patterns appearing in all of them with much the same degree of frequency, and that persons belonging to different classes, such as students in science and students in art, farm laborers, men of culture, and the lowest idiots in the London district, show no decided difference in their finger prints, it seems to be proved that no sensible amount of correlation exists between any of the patterns on the one hand and any of the bodily faculties or characteristics on the other. It seems absurd, therefore, to hold that, in the struggle for existence, a person with, say, a loop on his right middle finger has a better chance of survival or a better chance of early marriage than one with an arch. Consequently, genera and species are here seen to be formed without the slightest aid from either natural or sexual selection, and these finger patterns are apparently the only peculiarity in which panmyxia, or the effect of promiscuous marriage, admits of being studied on a large scale.

He says that results of panmyxia in finger-markings corroborate his arguments in Natural Inheritance and elsewhere to show that "organic stability" is the primary factor by which

the distinctions between genera are maintained. Consequently, the progress of evolution is not a smooth and uniform progression, but one that proceeds by jerks, through successive "sports" (as they are called), some of them implying considerable organic changes, and each in its turn being favored by natural selection.

Galton's explanation of this specific stability is as follows: The child inherits in part from the parents, in part from more remote ancestors; and since the sum of its ancestry, or, as Galton terms it, the mid-parentage, is on the average nearer than the exceptional parents to the mean of the race, the children of selected parents are on the average more mediocre than their parents.

I have tried to show that, while the child is descended from a long line of ancestors, it inherits from none but the two parents, and that it can only be said in a figurative sense to inherit from more remote ancestors. I shall soon refer to proofs that the persistency of inherited types is due to natural selection, and not to any principle of organic stability independent of selection.

If this is true, if the stability of specific types is due to the survival of the fittest, why do we have a type and not a fixed standard? If speed and strength and courage are good things, why is not every individual as swift as the swiftest, as brave as the bravest, and as strong as the strongest? Why does not every individual have every useful quality developed to the highest excellence to which it may attain in any individual of the species? Why should we find that diversity among individuals which usually passes under the name of "variation"?

We can measure strength and can treat it abstractly, and we can artificially select and breed from the strongest members of a stock, neglecting all other features; but this is not what takes place in Nature.

Here the most favored individuals are not the strongest, but the ones in which all the qualities of the species are most perfectly co-ordinated with each other in relation to the external world. Excessive strength may involve deficiency in some other essential, and the mean or average strength of the species is that degree of strength which is most in harmony with the mean degree of development of all the other characteristics of the species; and the individuals who depart too widely from this mean, either through excess of strength or deficient strength, are the ones which are exterminated.

Galton has himself given such a clear statement of the way a type is established by selection that it can not be improved upon, and I quote it in his own words:

"Suppose," he says, "that we are considering the stature of some animal that is liable to be hunted by certain beasts of prey in a particular country. So far as he is big of his kind, he would

be better able than the mediocres to crush through the thick grass and foliage whenever he was scampering for his life, to jump over obstacles, and possibly to run somewhat faster than they. So far as he is small of his kind, he would be better able to run through narrow openings, to make quick turns, and to hide himself. Under the general circumstances it would be found that animals of some particular stature had on the whole a better chance of escape than any other; and if their race is closely adapted to these circumstances in respect to stature, the most favored stature would be identical with the mean of the race. Though the impediments to flight are less unfavorable to this (stature) than to any other, they will differ in different experiences. The course of an animal might chance to pass through denser foliage than usual, or the obstacles in his way may be higher. In that case an animal whose stature exceeded the mean would have an advantage over mediocrities. Conversely the circumstances might be more favorable to a small animal. Each particular line of escape might be most favorable to some particular stature, and, whatever this might be, it might in some cases be more favored than any other. But the accidents of foliage and soil in a country are characteristic and persistent, and may fairly be considered as approximating to a typical kind. Therefore those which most favor the animals of the mean stature will be more frequently met with than those which favor any other stature, and the frequency of the latter occurrence will diminish rapidly as the stature departs from the mean.

"It might well be that natural selection would favor the indefinite increase of numerous separate faculties if their improvement could be effected without detriment to the rest: then mediocrity in that faculty would not be the safest condition. Thus an increase of fleetness would be a clear gain to an animal liable to be hunted by beasts of prey, if no other useful faculty was thereby diminished.

"But a too free use of this 'if' would show a jaunty disregard of a real difficulty. Organisms are so knit together that change in one direction involves change in many others; these may not attract attention, but they are none the less existent. Organisms are like ships of war, constructed for a particular purpose in warfare as cruisers, line-of-battle-ships, etc., on the principle of obtaining the utmost efficiency for their special purpose. The result is a compromise between a variety of conflicting desiderata, such as cost, speed, accommodation, stability, weight of guns, thickness of armor, quick steering power, and so on. It is hardly possible in a ship of any established type to make an improvement in any one of these respects without a sacrifice in other directions. If the fleetness is increased, the engines must be

larger, and more space must be given up to coal, and this diminishes the remaining accommodation.

"Evolution may produce an altogether new type of vessel that shall be more efficient than the old one, but when a particular type has become adapted to its functions, through long experience, it is not possible to produce a mere variety of its type that shall have increased efficiency in some one particular without detriment to the rest. So it is with animals."

This quotation from Galton shows how a type may be established by selection, and it also shows why it is not possible to make any great and permanent change in the type of one characteristic of an organism unless changes at the same time occur in the type of other characters of the same organism. It also follows that a breeder of domesticated animals or cultivated plants who devotes his attention to one characteristic exclusively must soon reach a point where no further improvement in this quality is practicable unless the spceies is at the same time modified in other respects. This fact does not prove that specific stability is due to anything else than selection. It only proves that no great change is possible without the co-ordinated modification of correlated features, and this is just what we should expect as the effect of long ages of selection.

The passage I have quoted from Galton seems to indicate that, after all, he may believe that the specific types of zoölogy and botany are nothing more than the persistent effects of past selection, and that his statement that "organic stability is independent of selection" may refer to present selection only.

These statements are clear and explicit, however, and they have been interpreted by most readers as a flat contradiction of the view that the mechanism which leads to the formation of new types is identical, on its vital side, with that which preserves established types; the view that the differences between the two are differences in the external world.

He says (Nature, September 4, 1885): "It is some years since I made an extensive series of experiments in the produce of seeds of different sizes, but of the same species. . . . It appears from these experiments that the offspring did *not* tend to resemble their parent seeds in size, but to be always more mediocre than they; to be smaller than they if the parents were large; to be larger than the parents if the parents were very small," and that the analysis of the family records of heights of 205 human parents and 930 children fully confirms and goes far beyond the conclusions obtained from seeds, as it gives with great precision and unexpected coherence the numerical value of the regression toward mediocrity. He says that this regression is a necessary result of the fact that "the child inherits partly from his parents, partly from

his ancestors. Speaking generally, the further his genealogy goes back, the more numerous and varied will his ancestors become, until they cease to differ from any equally numerous sample taken at haphazard from the race at large. Their mean stature will then be the same as that of the race; in other words, it will be mediocre." He illustrates this by comparing the result of the combination in the child of the mean stature of the race with the peculiarities of its parents to the result of pouring a uniform proportion of pure water into a vessel of wine. It dilutes the wine to a certain fraction of its original strength, whatever that strength may have been.

He then goes on to the deduction that the law of regression to the type of the race "tells heavily against the full hereditary transmission of any rare and valuable gift, as only a few of the many children would resemble the parents. The more exceptional the gift the more exceptional will be the good fortune of a parent who has a son who equals, and still more if he has a son who surpasses, him. The law is even-handed; it levies the same heavy succession tax on the transmission of badness as well as goodness. If it discourages the extravagant expectations of gifted parents that their children will inherit all their powers, it no less discountenances extravagant fears that they will inherit all their weaknesses and diseases. . . . Let it not for a moment be supposed that the figures invalidate the general doctrine that the children of a gifted pair are much more likely to be gifted than the children of a mediocre pair; what it asserts is that the ablest of the children of one gifted pair is not likely to be as gifted as the ablest of all the children of many mediocre pairs."

In his recent work on Finger Prints he says: "It is impossible not to recognize the fact so clearly illustrated by these patterns in the thumbs that natural selection has no monopoly of influence in the construction of genera, but that it could be wholly dispensed with, the internal conditions acting by themselves being sufficient. Not only is it impossible to substantiate a claim for natural selection that it is the sole agent in forming genera, but it seems, from the experience of artificial selection, that it is scarcely competent to do so by favoring mere varieties in the sense in which I understand the term. Mere varieties from a common typical center blend freely in the offspring, and the offspring of every race where statistical characters are constant necessarily tend, as I have shown, to regress toward their common typical center. A mere variety can never establish a sticking point in the forward course of evolution." He therefore holds that, while specific stability is due to inheritance from a long series of ancestors, the transmutation of species is due to the sudden appearance

of "sports," which, if useful, are seized upon and perpetuated by selection.

He says that a sport is a substantial change of type effected by a number of small changes of typical center, each more or less stable, and each being in its turn favored and established by natural selection to the exclusion of its competitors.

"The distinction between a mere variety and a sport is real and fundamental."

This generalization, based upon definite numerical data, is so fundamental and far-reaching that a critical discussion of the evidence is most important.

IMITATION AMONG ATOMS AND ORGANISMS.

By EDMUND NOBLE.

DURING the past dozen years scientific writers, American as well as European, have given a certain amount of attention to the part played in human life by imitation, with especial reference to the conditions under which children acquire from parents and associates the salient characters of individual and social habit. But the examples drawn upon for illustration have been narrow in their range, while the analogous process of assimilation among the lower animals and in the realm of the inorganic has received but scant recognition. It is proposed in the present article to connect the three classes of phenomena by formulating a general law which may serve, provisionally at any rate, to cover them all, and then to group the phenomena in their various natural divisions.

Without taking note of its unimportant and obvious qualifications, the statement may be made that all things free to move, capable of becoming closely associated, and impelled to movement by the system to which they belong, tend to come together when they are likes, and to be separated when they are unlikes. If we regard this tendency from the point of view of the movement, we shall say that likeness of things involves association of them in the degree of their likeness, and that unlikeness of them involves dissociation of them in the degree of their unlikeness; while, if we regard the tendency from the point of view of the things themselves, we shall say that association of things involves likeness of them in the degree of the association, while dissociation of things involves or implies unlikeness of them in the degree of the dissociation. These truths may be expressed in a more general way by saying that in systems the association of likes involves the least degree of resistance among them, while

the association of unlikes involves the utmost degree of resistance. It follows that where unlikes are associated, the resistance offered to their union will tend (1), where they are forcibly held in association, to make them likes; and (2) where they are free to move, to dissociate them. This law of assimilation, as we may briefly call it, finds illustration over so vast a field that it may fairly be described as a universal character.

If we begin, then, with the most complex of all the phenomena known to us, our first illustrations will be drawn from the realm of mind. The fact that cognition is a process of the association of like and the dissociation of unlike impressions, and the further fact that all the activities of thought, from reasoning of the lowest to reasoning of the highest kind, involve the association of like and dissociation of unlike elements—these are psychological truths of the utmost certainty. At the outset of all knowing is the indispensable condition that unless we can connect the thing perceived with some other things already known, and thus recognize our object as a like of those things, we can not know it at all, and it can not become a part of our store of mental experiences; while the very act by which we know it involves dissociation of it as an impression from all the impressions which it does not resemble. From this, the simplest form of knowing, to the most elaborate process of the reasoning faculty; from the recognition of single objects as like others to the recognition of classes of objects as like other classes; from the discovery of a causal relation between one set of objects or changes that is like the causal relation between another set of objects or changes to the discovery of the causal likeness connecting great groups of objects and activities, and finally all objects and changes whatsoever, there is throughout the same process at work—the process of the association of likes and the dissociation of unlikes—that conditions the mode of all our mental operations. So-called thought or reflection, for example, is simply the recovery into consciousness, for the purposes of knowledge, of cognitions more or less simple, more or less complex; cognitions recoverable as images, symbols, or terms from the classes in which they have been first associated by the mind; and the sense of pleasure felt by a thinker in discovering analogies can spring only from satisfaction of the demand, even in mental processes, that likes shall be brought together and unlikes separated. Classification in all its forms, whether in the ordinary business of life, as a means to scientific investigation, or for the ends of philosophic thought, illustrates the same necessity: at first unlikes and likes are mingled indiscriminately, and at first the mind regards them, if roughly, as being alike; but a sense of unrest leads to further examination of the aggregated elements until, by a more con-

scious and complete knowledge of them, they are found to be likes and unlikes, and are associated and dissociated accordingly.

The elements of coherent systems, whether of thought or language, always have their relations facilitated by likeness and impeded by unlikeness; hence we find in such systems that it is resemblance which is the bond of their union. Just as views in science or philosophy, schools in literature or art, are related to each other by varying degrees of likeness, the whole forming a group through which each of the parts thereof is rendered intelligible, so concepts and the words representing them are interrelated by degrees of resemblance, and so every term we can use is really intelligible to us only through its connection—a connection of likeness more or less proximate, more or less remote—with all other terms whatsoever. This is true, moreover, not only of all words as they exist at a particular moment, and are in use for particular concepts, but also for all the forms through which particular words have passed in their structural development. We bring new words into existence by connecting them, through likeness either of sound or of form, with words already familiar to us; and such new words, when we meet with them, become intelligible to us largely because of the likeness which connects them with known and intelligible elements of speech. When, moreover, a word is unfamiliar, the mental system rejects it as long as it remains a stranger and an unlike; but as soon as the mind, insisting on assimilation, obtains the satisfaction it seeks by change of form, the modified term, no longer meeting with resistance, becomes one of the system of likes. It is the same kind of assimilation as that seen in the use of *Shotover* for *Château Vert* which leads races to spell any foreign word they adopt in accordance with the analogy of their own tongue, and children to construct such grotesque plural forms as "foots," "mouses," "goodest," and "bringed." That in nearly all languages the vowels within a word tend to be assimilated to one another is a phenomenon encountered very early in the study of linguistics. The use of metaphor, again, which is largely the mental assimilation of a thing more or less unknown to something much better known, is universal.

Passing from the allied realms of cognition and speech to the sphere of human relationships, we shall find that here also likes tend to be associated and unlikes dissociated; that the resistance is greatest where the association is of unlikes, and least where the association is of likes. At the outset we must understand that likeness or unlikeness between human beings is a likeness or unlikeness not merely in structure but also in manner of acting; not only in structure and acting, as these are popularly understood, but also in thinking, in belief—not only, that is to say, in

body, but also in mind—not only in permanent and fundamental characters, but also in temporary and superficial characters. If men were exactly alike in every respect, we should find the greatest ease of association between men and men generally, as distinguished from association of beings human and beings not human. Yet upon the fundamental characters in which all men are alike there are superposed by advancing social and industrial complexity those superficial characters in which, for such characters, the members of particular groups come to be, on the one hand, more alike one another than, for the same characters, they can be alike men in general; and on the other, more unlike each other than, for the same characters, they can be alike men in general. Hence, even among human beings fundamentally alike we shall find abundant scope for movements both of association and dissociation.

First note the superior ease, even pleasure, which characterizes the relations of likes temporarily or permanently associated, and observe how, in the very facility of such relations, we are entitled to see a satisfaction of the demand that likes shall be brought together. The illustrations naturally take a wide range. Men of the same vocation, for example, find intercourse with each other, for the scope and ends of such vocations, much easier than with those engaged in other vocations. It is from likeness within industrial groups that the *camaraderie* of the trades and professions draws its spirit. The pleasure, again, with which artists, musicians, scientific and literary men come together manifestly has its origin in likeness of common pursuits, tastes, and aspirations. That facility of association is at its highest between men of like politics, men of like faith, men of like aims in any field of activity, has long been proverbial. Societies and clubs of every kind constitute so many classes of likes within which the elements of resistance are at a minimum, and this not because each individual is always or even often wholly like his fellow-member, but because there is a resemblance between them on some one or more sides which, being permanent, at least for the time, and valid for the ends of the association, facilitates the intercourse of all who during that time and for those ends come into contact with each other. Even when men gather for only temporary and general purposes—such as for those of social enjoyment—we often hear of religion or politics being tabooed, and this is done obviously as a means of avoiding the resistances of unlikeness—of bringing forward only those sides of human nature on which the associated individuals are for the time being alike. Intercourse is also much easier within than without the limits of class; the poor find among the poor the greatest facility of relation with their fellow-beings; so the possessors of

wealth are usually most at their ease in intercourse with the well-to-do. Who has not witnessed how quickly two abnormally stout men enter into confiding relations with one another; or how easily, between persons afflicted with a like disease or deformity, friendship is set up? Caste, group, and race prejudices of every kind, together with such distinctions as those implied in the names of aristocrat, commoner, bourgeois, official, proletariat, all imply and involve the coming together of likes and the separation of unlikes. In most countries there is still a strong though diminishing prejudice against alliances with foreigners; even among natives, marrying "below one's station" or "out of one's religion" meets with a certain amount of social as well as with much family resistance. Most people usually fall in love with those about their own age. Deaf-mutes almost invariably marry deaf-mutes.

Highly temporary likenesses are equally potent in promoting association. Their influence is seen in the pleasure we feel at the discovery in others of some character like to our own, even if that character be no more than a gleam of intelligence in the lower animals. We note it constantly in the unifying effect which the wearing of a common badge or uniform has upon large bodies of men brought together for special ends. So in moments of exaltation or depression, as in the excitement of conflict or intoxication; under the influence of music or during religious worship; the ordinary differences belonging to more permanent states lose their separative power, and men come into unwonted facility, even pleasure of relation with each other. It is supposed that even between deadly enemies chancing to meet at the dinner table there passes a flash of momentary reconciliation. It is certain that shipwrecked men do not quarrel over politics; that the starving are usually free from religious bigotry; and that in the presence of a general bereavement, the clamors of faction and the prejudices of class are silent. The power of a war and of the comradeship of battle to annihilate distinctions usually recognized in time of peace is notorious. In all these cases, and in all the cases which they represent, we see great importance suddenly given to one side of men's natures—to some all-absorbing feeling or experience in the presence of which the ease of association with likes becomes extended for the moment to each of the human beings by whom the same experience is shared, whether they be few or many; in other words, the unlikenesses which normally separate men into more or less narrow classes lose their importance in proportion as some suddenly developed feeling gives prominence to resemblances either wider in character or more strongly felt.

Observe next how unlikes tend to be separated from the hu-

man systems in which they appear, and to be associated, in the act of separation, according as they are likes to each other. From whatever causes the unlikenesses which differentiate men from each other take their rise, it is manifest that even in the most minute of them the law of likes and unlikes finds illustration. Perhaps the most common and familiar example of this simultaneous association and dissociation is afforded by the breaking up of a social gathering into minor groups of likes that do not easily coalesce. In all such cases the individuals who so naturally fall into pairs or groups move from associations that involve the greatest resistance into associations that involve the least resistance, while the movement itself (given the need of association) is manifestly the product of the stress of the greater resistance.

In what multifarious ways this stress is exerted may be easily shown. As a small group of men surrounded in battle by a larger force naturally come together and are compacted for defense by the stress of those who attack, so the individual members of classes or races despised, hated, or feared, when persecuted by the community in which they live, are in like manner thrust and welded together by the stress which they encounter. Individuals, again, who differ from their fellows to the extent of being unable or unwilling to work—to take part in those co-operative activities that are necessary for individual as well as social maintenance—meet with the resistances which failure in self-maintenance involves, and are by them, though nominally by society, thrust into hospitals or poor-houses; while men whose actions are unlike those of others beyond the amount of difference permitted by law are dissociated, either by exile or imprisonment, from the communities which they injure. When expulsion of the unlikes is not practicable, there is association of them as prisoners within the system. Savages, again, often abandon or destroy individuals deformed at birth or incapacitated from social duties by age; even a comparatively advanced people like the Spartans exposed their weaklings to death by starvation. That there is still a tendency to offer undue resistance to the unlikenesses of physical and mental deformity is shown by the treatment of lunatics and criminals even in the most civilized countries; not many years ago positively cruel, it is still in many cases culpably careless and inadequate. The treatment ordinarily given by human beings to the lower animals; offenses against the helplessness of children and women; the oppression of individuals by autocrats, by governments, by official tyrants abusing power intrusted to them by the people, and by capitalists taking unfair advantage of the economic condition of those whom they employ—these are all cases of stress directed against unlikes. So shortcomings of men of every kind—veritable unlikenesses—are in numberless ways

made the goal of individual or social stress; even ridicule and slander are forms of aggression, based on the real or fancied discovery of fault, and therefore unlikeness in the person assailed. But the action here illustrated, so far as human beings are concerned, is not necessarily moral and not necessarily immoral. Men may be in advance of as well as behind their age—may be larger as well as smaller than their fellows; yet the social system offers the same resistance to the individual too greatly contemplating the good of his kind as to him who wantonly plots its harm.

We thus come to note how the social group or system tends constantly to the production of conditions of least resistance within itself—how, that is to say, its resistance to unlikeness acts as a stress compelling likeness among its units. The fact that profound differences between individuals are not to be eradicated by the social stress after their appearance is quite consistent with the power of that stress to assimilate human beings to each other in their more superficial and temporary characters. The tendency to do as others do is universally felt, no matter to what extent, in individual cases, it may or can be resisted. It appears both as imitation of the particular acts of particular persons and of the acts in which a number of persons are generically alike; as imitation not only by the one of the many, but also by the many of the one. It usually begins—for wholly voluntary actions, at any rate—in that interesting process by which people are assimilated to each other in their views and beliefs.

Submission of opinion, whether accompanied by imitative action or not, is clearly a path of least resistance—a way in which men avoid the difficulties of differing from the community in which they live. And when action is involved, as it usually is, the process shows us the enormous assimilative influence which it brings to bear upon human development. It may be said, indeed, that civilized human beings acquire their normal activities as such largely through the molding influence which the social community exerts upon them from their earliest years.

This stress impelling individuals to imitate society is well seen in industrial organization, and is thus obvious in the lowest as well as the highest stages of human development. The civilized human being who enters a savage community will be compelled to go half naked through very lack of any means of producing clothes to which he has been accustomed; he will be forced to hunt or fish for a living for the reason that there is yet no system of co-operative supply in existence; in the absence of those functionaries, he must become his own farmer, his own soldier, his own tailor and shoemaker, his own doctor, even his own priest. So a savage entering civilized society will be forced to

wear clothes, partly by social intolerance for human nudity in public, and partly because of the facilities for obtaining clothes, with all which that implies; there will now be no game to pursue and no need to pursue it, since the man's food supplies will come from the agents of the industrial system; he will soon lose his primitive, many-sided industrial capacity, for he will have an army of stock-raisers, farmers, tailors, shoemakers, house-builders, and doctors at his service; while in time society will impose, in place of the powers which it abstracts, new functions and activities, assimilating him industrially to the units of which it is already composed. In both these cases, moreover, likeness will be enforced by the resistance offered to unlikeness, and not by any inherent superiority of one system or any inherent inferiority of another; for savages who have not yet learned to cooperate are as much held to their rude industrial methods by the stresses that impel to likeness as civilized men are held by such stresses to the vastly more complex and highly organized activities of the modern society.

The same is true of nonindustrial forms of social organization. As a community imposes its industrial methods upon its own and upon intruding members, whether it represent a high or a low stage of human society, so does a community, quite irrespective of the degree of its development, insist upon a certain likeness of habits and customs in the units of which it is composed. A civilized man forced to live among savages will find it impossible to avoid barbarous methods of living, just as a savage compelled to sojourn in a civilized community will inevitably adopt the manners of the race among whom his lot is cast. In all communities whatsoever, and under ordinary circumstances valid for the majority of men, it is vastly easier to imitate others in general characters than to differ from them in those characters, while the difficulty of differing becomes almost insuperable when the stresses tending to assimilate the individual to the sum of individuals are exerted directly by the group or community as a whole. All acts of race assimilation in history—many of them already accomplished, some of them still going on—all so-called civilizing processes, whether carried out by individuals or by peoples, and all proselytizing movements, by whomsoever conducted, are but so many illustrations of the general process. Such modifications, moreover, as have been wrought in the native races of India, and in the negro of the United States, by dominant populations in those countries, are going on within each nation, each city, and every social group, however large or small its dimensions may be. For if the traveler, when living in strange countries, finds it expedient, if only temporarily, to conform to the customs of the people he meets—such customs being imposed upon him by the

very resistances which divergence from them entails—he none the less, on his return home, finds his actions in social intercourse determined by the same need of conforming to some larger or smaller group of which he may happen for the time to be a member. It is because of this "doing at Rome as Rome does" that social gatherings are said to succeed best and to be most enjoyable when the guests are all alike each other on certain social sides of human nature, or are willing to appear to be thus alike during the period of their association. The fact that the social code, as it is sometimes called, frowns upon the guest who would take more than his share of the attention or time of the company, and encourages the host to an equal distribution of his favors to all of them alike—this shows how thoroughly, even in the social circle, imitation of the group is the direction of greatest ease, and how it is the stress of the resistances offered to unlikeness by the group as a whole which impels the members of it to those acts of imitation by which they are more or less temporarily assimilated.

The very description, again, of costumes as *de rigueur* for certain special occasions contains a suggestion of the resistance which the social group opposes to unlikenesses in dress. The attacks sometimes made upon strangely attired persons in so highly conservative a country as China have had their parallels even in the highly progressive countries of Europe and America. A similar antagonism is manifested to nonconformity in social manners; and all formulæ of such manners—the etiquette at baptisms, weddings, and funerals; established methods of paying and receiving visits; prescriptions of what to do and what not to do at the dinner table—are simply means, among those who attach importance to these minutiæ, of avoiding the resistances that would inevitably be encountered were there many ways, instead of a generically common manner, of behaving on social occasions.

The resistance offered to unlikenesses among associated individuals is also announced in that universal human character, the passion for equality among men—the tendency, however vaguely or vividly it may be felt, to insist upon it that those with whom we come into contact shall, in as many respects as possible, be likes of ourselves. Jealousy of special privilege, with its spirit embodied in such phrases as "fair play," "start equal," "share and share alike," "a fair field and no favor," begins to manifest itself very early in the life of the individual: mere children, when associated, insist in multifarious ways on likeness of treatment; anything like favoritism in the distribution of gifts or the bestowal of attention, as well as all unfair advantage in games, they resent with surprising promptness and vigor, often also with indignation. In adults this jealousy of unequalness finds

expression over a much wider field, and finally gives character to the whole social system. All rules governing the activities of large or small bodies of men, such as regulations in factories, hospitals and prisons, by-laws in cities, and general laws framed for communities and nations, are manifestly means of providing against unequal acting of individuals—of securing, that is to say, the like acting, under particular and specified circumstances, of all the individuals associated. The sense, early developed, in the individuals of a community that they ought to be equal before the law, with the restiveness which they manifest under all inequalities of its operation; the claim that men shall be politically as well as legally equal; and the demand always made, if not always satisfied, for universal suffrage, first for men, and then for women—at first with limitations of race, property, or sex, and finally without such limitations—all these explain the progress which the world has been making during the last fifty years toward an ideal democracy—toward a condition of ideal political equality between the units that make up a human society as the very condition and means of least resistance between those units.

But men do not remain satisfied with likenesses set up by statute law, with resemblances imposed by a governing body. They aim, more or less consciously, more or less outspokenly, at a common degree of social well-being for all the individuals of a community, and, rightly or wrongly, regard inequalities of wealth, even inequalities of industrial power, as imperfect stages of human development that are to be outgrown. Hence it is that men denounce monopolies, and declare abnormally large accumulations of wealth in private hands to be iniquitous, because inequitous; hence, too, it is that, in the common jealousy of privilege, there is to be found every form of hostility to exceptional social power and rank, from the dislike in which it is merely envied to the anger by which it is openly attacked. Socialistic schemes of reform are really schemes for diminishing those inequalities which still offer resistance to the association of men—schemes, that is to say, for making men in social, political, and legal relations, in powers, privileges, and responsibilities—more than ever before likes to each other. Even religions illustrate the progress from a belief and acquiescence in special privileges held out to a favored few to an expectation and demand for the salvation of all; for if the pagan had to content himself with the satisfaction of knowing death as the universal leveler, asking with Cicero (Tusculan Disputations) "Can what is necessary for all be a source of misery to one?" the Christian, who claims the equality of all men before God, looks forward to a life hereafter in which all earthly unlikenesses are to be removed.

We shall next note that when unlikes are forced to remain

associated, such unlikes being kept together for longer or shorter periods, the resistances which arise operate as a power tending to assimilate them. This process of assimilation is manifested in all degrees of our intercourse with others. Men rarely come into contact with each other, even for special and temporary ends, without feeling the molding influence of more or less unlike habits, manners, opinions, and speech. Unless our ways of thinking, acting, and speaking are so firmly established as to be unchangeable, we can not long remain in the society of others without feeling that the differences which separate us from them are gradually being worn down, if not disappearing altogether: strenuous as our determination may be, Nature herself seeks to lessen resistance, and thus guides us insensibly into the path which offers the least. Thus it is (in indifferent things, at any rate) that we gain our opinions and beliefs from those about us, that we unconsciously acquire the gestures and mannerisms of relatives and friends—that, in a word, we come at last to be profoundly modified by the more permanent characters of our human surrounding. In speech alone the change wrought is often considerable. Few succeed in avoiding the use of colloquialisms constantly heard, and fewer still escape the insidious influence of phrases and idioms peculiar to districts and countries: newcomers may at first regard them as strange, even barbarous, yet in the end they employ the novel forms as frequently and as unconsciously as the native. The very features of human beings living in close association with each other are known to undergo assimilation. The fact, again, that jockeys, hostlers, and cowherds sometimes betray more or less distant resemblances to the animals with which they habitually associate is well known; and although animals do not in feature grow to be like human beings by contact with them, it is certain that in the character of intelligence, as in the case of the dog and the cat, as well as in tameness generally, as in the case of cattle and poultry, a real and profound assimilation of them to men has undoubtedly taken place.

Fashion in all its forms illustrates the same assimilative process. The first fashions are seen under the domestic roof: there, children imitate their parents not only in speech, gesture, and action, but also sometimes in opinion and bent of mind, and (for the sons, at any rate) occasionally also in vocation. Men imitate individuals as well as communities; they borrow from each other mannerisms of dress, of conduct, of opinion, and even of literary style, whenever attention is strongly called to any of these; even maladies have been known to become fashionable. A remarkable exploit in athletics usually sends a fever of emulation through the sympathetic members of a social group, just as a fashion set

in literature, science, art, or philosophy inspires a thousand imitators. All composition, whether of prose or poetry, is in the ground of it imitative—a fact sufficiently suggested by the grotesquely moral turn ordinarily given to college and school essays, by the accession of literary power which always follows much reading, and by the imitation of any particular author or style to which great liking for one or the other inevitably leads. What has been called the contagiousness of example is really the power of a strong impression, and therefore practically of stress, to produce likeness. This may be noticed at public meetings, where people applaud or cheer gregariously, and do other acts, such as those of sitting or standing, with obvious reference to what others are doing. The ease with which a stammerer communicates his defect to another is a matter of common observation. Movements or actions of persons sitting together, such as yawning, coughing, and the like, tend to be propagated more or less through the whole of them by unconscious imitation. To the same process is due the spread of more or less hysterical ailments among a company of persons, such as the often-recorded mania for mewing among nuns, or the propagation of convulsions among girls in factories. Simple movements, like the shifting of a chair, the rustling of a paper, audible change in the position of the body, often follow involuntarily in others after they have occurred in one of the persons associated. If in a thoroughfare a man be encountered staring intently and conspicuously at some portion of the sky, most of those who see him will at once direct their gaze in the same direction. A man watching an athletic feat, or a stroke at billiards, in which he is deeply interested, will often at a critical moment imitate the attitudes or action of the performer.

The law is further abundantly illustrated by facts relating to the lower animals. These find the greatest ease of association as likes, and come together everywhere in Nature on the ground of likeness. The general evidence of this is familiar, and mention need be made here only of a representative example. In the Falkland Islands, for instance, where the cattle have run wild, and where they are of several different colors, each color keeps in a separate herd, often restricted to one part of the island; among the wild horses of Paraguay, those of the same color and size associate with each other; in Circassia three races of horses exist which, when living in freedom, always refuse to mingle and cross; on the Färöe Islands the half-wild, native black sheep resist attempts to breed them with imported white sheep; in the Forest of Dean and the New Forest the dark and pale colored herds of fallow deer have never been known to mingle; the merino and heath sheep of Scotland, if the two flocks are mixed together, will

each breed with its own variety; Ancon sheep have been observed to keep together, separating themselves from the rest of the flock when put into inclosures with other sheep; "the female of the dog" (according to Prof. Low, an authority on domesticated animals), "when not under restraint, makes selection of her mate, the mastiff selecting the mastiff, the terrier the terrier, and so on"; pigeons pair, when choice is free, with their own kind; flocks of white and Chinese geese, even when associated by the breeder, keep themselves distinct. The fact that organisms prefer to associate and breed with their likes is also widely shown by the habits of birds. Describing a molluscan fauna in the Sandwich Islands, Mr. Gulick says: "We frequently find a genus represented in several successive valleys by allied species, sometimes feeding on the same, sometimes on different plants. In every such case the valleys that are nearest to each other furnish the most nearly allied forms; and a full set of the varieties of each species presents a minute gradation of forms between the more divergent types found in the more widely separated localities."

The recognition marks of insects, birds, and other animals imply and involve the association of likes and the separation of unlikes. The mimicry of one set of organisms by another, whether the imitation be of color, shape, or both, is manifestly a means of acquiring the superior ease of living which assimilation offers to the imitating kind: the mimickers always occupy the same region as the species mimicked, and the resemblance wrought is sometimes (Darwinism, page 256) advantageous to both. All association of organisms involves likeness between them, and when, by unequal conditions, unlikeness is set up in sufficient degree, that unlikeness involves dissociation of the unlike members of the group, accompanied by the resistance which sterility offers to the intercrossing of those members. The like individuals, moreover, are only held together by the constant operation of assimilative processes: one of these is the free intercrossing of all the associated members, whereby the individual is maintained true to the average; the other is the resultant tendency of the organism to transmit and perpetuate only those characters due to influences and conditions that are the common experiences of all the members of a kind, as opposed to characters arising out of special individual experiences.

The group of animals, like the group of men, expels unlikes that appear in its midst. Thus ants eject intruding members of alien kinds; geese and hens drive away strange birds of their own species; crows and rooks expel wrongdoers from their midst; domestic pigeons attack and badly wound sick, young, or fallen birds; beavers dissociate idle members from their colony; a wounded herbivorous animal returning to its companions is

usually attacked and gored to death; elephants not only expel a "rogue" from the herd, but have been known to refuse refuge to one of their number who had escaped into the jungles with the bandages of the capturer still on its legs.

It should be added that the organism itself, and the organic structure, everywhere illustrates the principle of the association of likes and the dissociation of unlikes. All tissue systems in the organism are systems whose units are likes to each other, and the likeness which those units exhibit is a likeness maintained by the assimilative force of the organism acting a whole. So all food material taken into the organic system—which is really a community of cells—must undergo assimilation as the very condition of its admission to association, while all material that can not be associated is expelled, either by dissociation without or by dissociation within the system.

In the inorganic world the same law holds good. Its most general evidence is afforded by the fact that matter is always associated with matter, and that where free to move it always constitutes a system of which the parts of like density are associated and the parts of unlike density dissociated. In a general way the bodies which constitute the solar system occupy positions in that system according to the degree of their density, the denser planets lying nearer to, those less dense farther away from, the sun. The ring system of Saturn shows a like collocation, due to differences and likenesses of density. In the earth itself (omitting complications of gravitation produced by internal heat) the denser solids always tend to move nearer to the earth's center than the liquids; the liquids thus displaced take precedence in position over the atmosphere; while even the air shows a gradually diminishing density in a direction away from the earth. That which, moreover, is observable in our own solar system may reasonably be predicated of stellar aggregations generally: most of the planetary nebulæ and star clusters display a gradually increasing density from circumference to center; comets, densest at their nucleus, visibly diminish in mass as their fanlike streamers recede from the sun; in meteor orbits the densest bodies travel first, the remainder, roughly speaking, following in the order of their density. In the star system itself, there are signs of the same kind of segregation, one region of the Milky Way being as remarkable for the multiplicity of its suns and its almost complete absence of nebulæ as are the other regions of the heavens for the fewness of their stars and the large number of incipient systems which they contain.

What is true of matter in the varying degrees of its density is also true of the different types of matter; for whether the atom constitutes the molecule, as in the case of a few of the elements,

or the molecule be made up of two or more atoms, as in the case of most of the elements, it is undisputed, not only that the uniting parts are likes to each other, but that the molecules which they form are also likes to each other. That which, moreover, is especially obvious in the case of the elements, where the molecule is always made up of the same kind of atoms, is none the less true of compounds; for, however superficially unlike the atoms or molecules may be that enter into combination to form such compounds, and whether the matter formed be what we know as inorganic or what we know as organic—whether it be extremely simple, as in the case of water, or highly complex, as in the case of albumin—the resultant system is in every instance a system whose unit parts all possess the same general character.

The power of material systems to dissociate unlikes is best seen when the dissociating stress is exerted by matter in the liquid or gaseous state—in a form, that is to say, in which the power to dissociate is at its maximum and the resistance to dissociation at a minimum. If we thrust a ball of wood into a volume of water, the entering mass is immediately expelled to the surface, and it is thus expelled for the reason that it possesses less density than water, and is therefore an unlike: the act of dissociation, moreover, is manifestly an act of the water system; for, if we remove the water, our wooden ball will descend freely through the space previously occupied by the fluid. So a balloon ascends through air because, being less dense than air, it appears in the air system as an unlike, and is by that system expelled to those regions of the atmosphere which resemble it in density: in this case, as well, the act of dissociation is an act of the air system, for, if the air could be removed, the balloon would not rise at all.

Unlikes, sufficiently free to move, often repel one another when forced into association. Zinc and lead, or zinc and bismuth, may be melted together, but they separate more or less completely during the process. Chloroform and water may be mechanically mixed, but when they are no longer shaken the two fluids part into distinct layers. If, upon oil placed in a receptacle, water be poured, the water will displace the oil; while, if mercury be added, it will displace both oil and water; the final result of the experiment—three layers occupying positions in the order of their density—being reached by acts involving both association and dissociation—association of the like parts of each layer, and dissociation of the unlike layers.

How likes are associated and unlikes dissociated may also be shown in most of the phenomena of cohesion, and especially in those wherein particles of matter assume the spherical or globular form. Where the medium is not apparent, as in the case of the sun, moon, and planets, the association of likes is alone displayed;

where the medium is more accessible to us, there is more or less suggestion of an act of dissociation by the system in which the parts become associated. Thus an atmosphere overcharged with moisture literally expels water from itself, first into fine vesicles, and later, by cumulative aggregation of these, into the drops which constitute rain; so when the vapor of water issues from the spout of a kettle, the air which it traverses condenses it into the droplets visible as steam. Water thrown upon a dusty surface; molten lead let fall from a tower in the process of shot-making; melted glass dropped into water—all these assume a more or less spherical shape under circumstances which suggest, not only cohesion of the parts, but also repulsion by the medium. The spherical shape assumed by oil dropped on water is not wholly due to cohesion of the parts of oil, but is also due in very large measure to the repulsive action of the water system itself. A still more striking illustration of these acts of simultaneous association and dissociation is yielded by mixing small quantities of water with large quantities of oil: here the water, in descending, breaks up into spherelike globules, each of which exemplifies at once cohesion of the intruding parts and repulsion by the receiving system. There is also to be added the evidence of smoke and vapor rings, the forms of which are largely determined by the action of the atmospheric system in which they are produced.

That assimilative action takes place within material systems is also to be noted. Such action is of several kinds, and includes (1) assimilation of movement, (2) assimilation of substance by diffusion, and (3) assimilation of mass or structure, the latter being divisible into (*a*) assimilation by change of form in the case of gross aggregates rudely associated, and (*b*) assimilation by changes of arrangement in the case of minute parts closely associated. The simplest form of assimilation is seen when volumes of two different gases are brought together within a closed receptacle; for, though the molecules of the two gases may originally possess different "kinetic" energy, they undergo in association a change by which the molecules of both gases come to have a like degree of the energy of movement. What is true of gases is true also of matter in each of its states: heat communicated to an aggregate is more or less rapidly distributed through it until all the parts possess, roughly speaking, like degrees or amounts of movement; a mass of metal heated in a furnace becomes gradually assimilated to the character of its surroundings; by a precisely similar process, the overheated earth radiates energy into the atmosphere. There is also the assimilative distribution of heat through liquids by means of convection currents: as the surface of the sea becomes cooled in winter, the cooler layers, grown heavier, sink, and are constantly being replaced by warmer water

from below. Vertical exchanges of temperature also take place between higher and lower layers of the atmosphere, while the difference of temperature between the polar regions and the equatorial zone results in the assimilative movements of the general atmospheric circulation. As ocean currents, like the Gulf Stream of the Atlantic and the Kuro Siwo of the Pacific, carry heat from the warmer to the colder regions of the earth, so air currents arise out of those differences of heat and of barometrical pressure which it is obviously their function, as far as possible, to remove. All atmospheric movements, in fact, however local or general their character may be, are either movements of direct assimilation by which the atmosphere is seeking, so to speak, to bring all its areas into like temperature and pressure with each other, or are disturbances involved and arising indirectly out of such acts of assimilation. It is only because the work done by these movements is being constantly undone through the agency of influences, permanent and temporary, that differentiate areas of the atmosphere in every part of the globe—setting up, for example, unlikenesses of temperature and pressure between the equatorial and polar regions, between continents or islands and the surrounding oceans, or between any area of the earth's surface abnormally heated or cooled and the surrounding parts of that surface, as well as between seasonal variations in such inequalities—that we have cyclones and anticyclones, tornadoes, blizzards, land and sea breezes, mountain and valley winds, sand spouts and dust whirlwinds, as well as various periodical and more or less local disturbances all over the world. It should be added that meteorological phenomena do but illustrate the wider interchanges that take place in the ether system, since the constant distribution, as electro-magnetic disturbances, of movement differentially accumulated in material aggregates—whether such disturbances take place within purely local limits, as in circuits artificially set up, or on a universal scale, as by diffusion from solar bodies—are all cases of the distribution of movement, and therefore cases of assimilation.

The diffusion of molecules through each other is also a common form of assimilation. Gases, if brought together, permeate each other until a tolerably like constitution for every larger or smaller area of the total volume has been reached; gas distributes itself equably through liquids, as in the case of effervescing drinks; solutions of salts brought into contact gradually intermingle. A soluble solid, when introduced into a liquid, usually assumes the liquid state to the extent of the capacity of the fluid for taking it up, as in the familiar case of sugar in tea or alum in water, while the liquid itself undergoes modification by the equable distribution of the particles absorbed. The uniform hardness of "hard" water, due to the presence of bicarbonate

of lime, and the uniform tenacity of solutions of soap in water, as shown in experiments with soap bubbles, both illustrate how equably substances held in solution are diffused. The evaporation of fluids into air, like the dissolution of solids in water, is in its results, at any rate, a case of assimilation to the character of the surrounding or adjacent medium; so that, the more we heat a bar of iron, the more progress does it make toward that vaporous condition in which it can easily be diffused through its environment. The mixing of metals also illustrates diffusion; for, whether it results in amalgams or alloys, whether the mixture be a merely mechanical association of the parts brought together or a chemical combination of those parts, the fact remains that for given areas, which may be large or small, the average degree of diffusion is the same. This is shown with especial clearness in those compounds of carbon and manganese with iron needed for a variety of industrial purposes, since such compounds would have none of their present commercial value were it not for the uniform diffusion through the iron of the substance employed to modify it.

Here, then, our treatment of the subject must draw to a close. While necessarily brief, it has been complete enough to reveal a process far reaching in its scope and of cosmical significance. We have seen how like units everywhere tend to be associated and unlikes dissociated; how unlikes, held in forcible association, tend to be more or less profoundly assimilated to one another; and how disturbances of prevailing uniformity tend to be equably distributed through the several media in which they occur. But we have also noted that the power impelling to these multifarious acts of assimilation, to these movements of association and dissociation, is not the power of the units themselves, but the power of the system to which they immediately belong; and we are thus warned of the important bearing which our law has upon two problems of the utmost generality in physics—namely, the problems of chemical affinity and gravitation. It is true that we have as yet no formula for explaining these manifestations of power by a single principle; that we do not yet know the real structure of ether; and that there is still needed a definite account of gravitation as an intelligible mechanical process. Nevertheless, the causal connection of both gravitative and chemical actions with the ether system is already obvious to physicists. That the power which accomplishes these actions does not reside in matter alone, but resides also in the ether system—is, in fact, a function of that system regarded as including both ether and matter—seems to be increasingly pointed to by the trend of recent physical research. Basing our final conjecture, therefore, on generalization from a wide array of facts, it may not be premature to

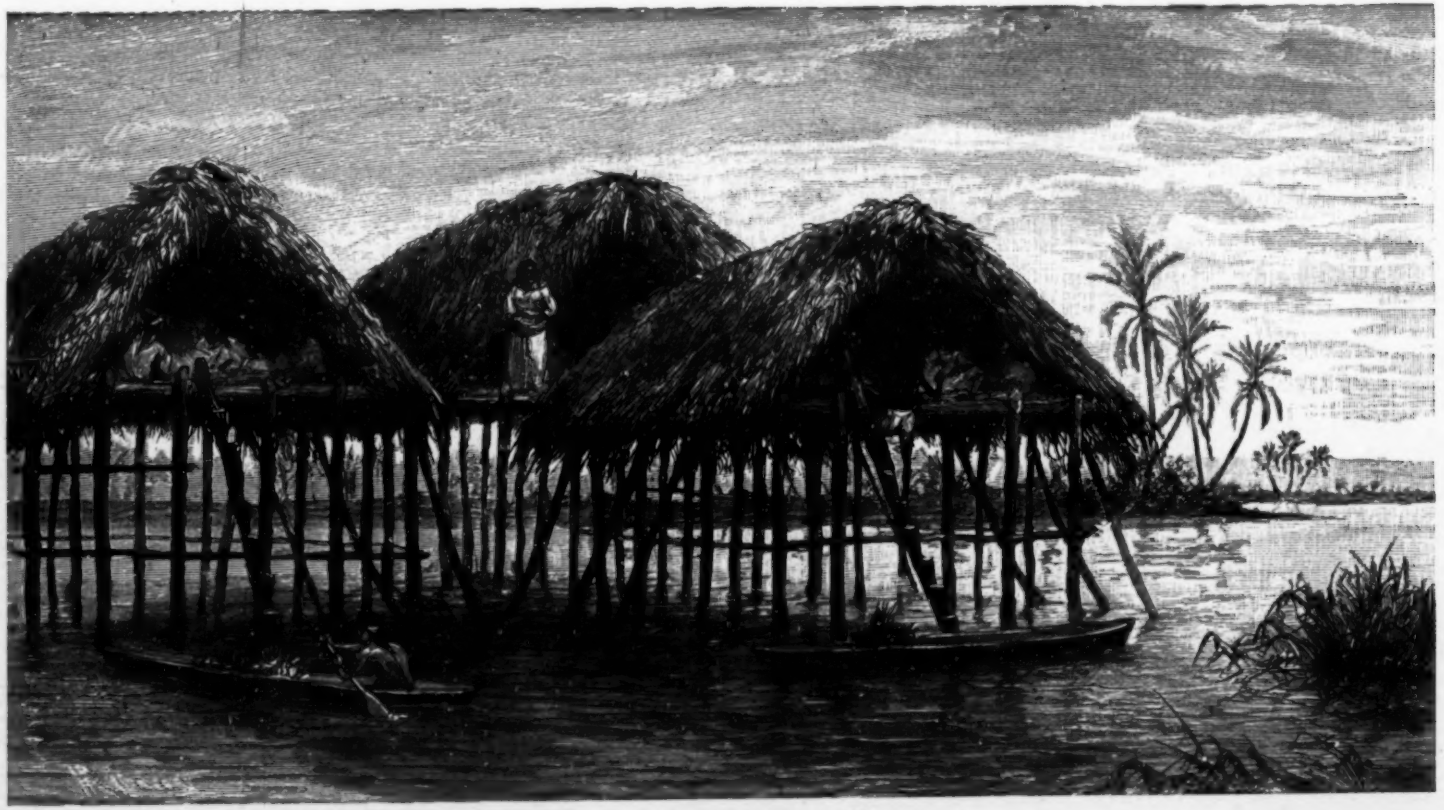
look to the ether system, not only for an illustration on the widest scale of the law of assimilation, but also for the ultimate source of all the phenomena in which the operation of that law can be traced. For whether the ether be continuous or granular, it clearly satisfies, by its very nature and uniformity, the demand that likes shall be associated, the while that, by the actions known as chemical and gravitative, it also fulfills the requirement that there shall be dissociation of unlikes. Lacking, as we do, all explanation of the actual mechanism of gravitation, we may none the less find its form suggested to us when we describe it as an act of dissociation by the ether system. And if this view be tenable, we should be justified in regarding the ether as primarily embodying the power manifested in the multifarious changes which we call evolution.

NATURAL FEATURES OF VENEZUELA.

By FREDERIK A. FERNALD.

THE first part of the American mainland seen by Columbus was Venezuela. On his third voyage, in 1498, he bore farther to the south than before, and had become convinced that he should not meet with any land on that course when his lookout descried three hilltops in the southwest. The island from which these peaks arose Columbus appropriately named Trinidad (the Trinity). Sailing on, he entered the chief mouth of the Orinoco and then skirted the island-fringed coast on his way to Haiti. The country is said to owe its name to Ojedo, who, on entering Lake Maracaibo the following year, noticed one of the Indian villages of pile dwellings on its shore. "Why, here," he said, "is a little Venice" (Venezuela), and this name became the designation of the whole region round about.

The great curve of the Orinoco divides the area of Venezuela into two unequal parts, the larger of which, lying to the north and west of the river, contains the more populous districts. Seven of the eight States of the republic lie wholly in this part, while most of the region south of the river and along its upper course is divided into Territories. The surface of the country is much diversified. In the extreme northwest, around the gulf and lake of Maracaibo, it is level and well watered. East of this tract a branch of the Andes crosses the country diagonally. Five of its peaks extend above the snow line, the highest, Concha, rising to fifteen thousand four hundred feet above the sea—between the height of Mount Whitney, in California, and that of Mont Blanc. From this peak descends a small glacier which



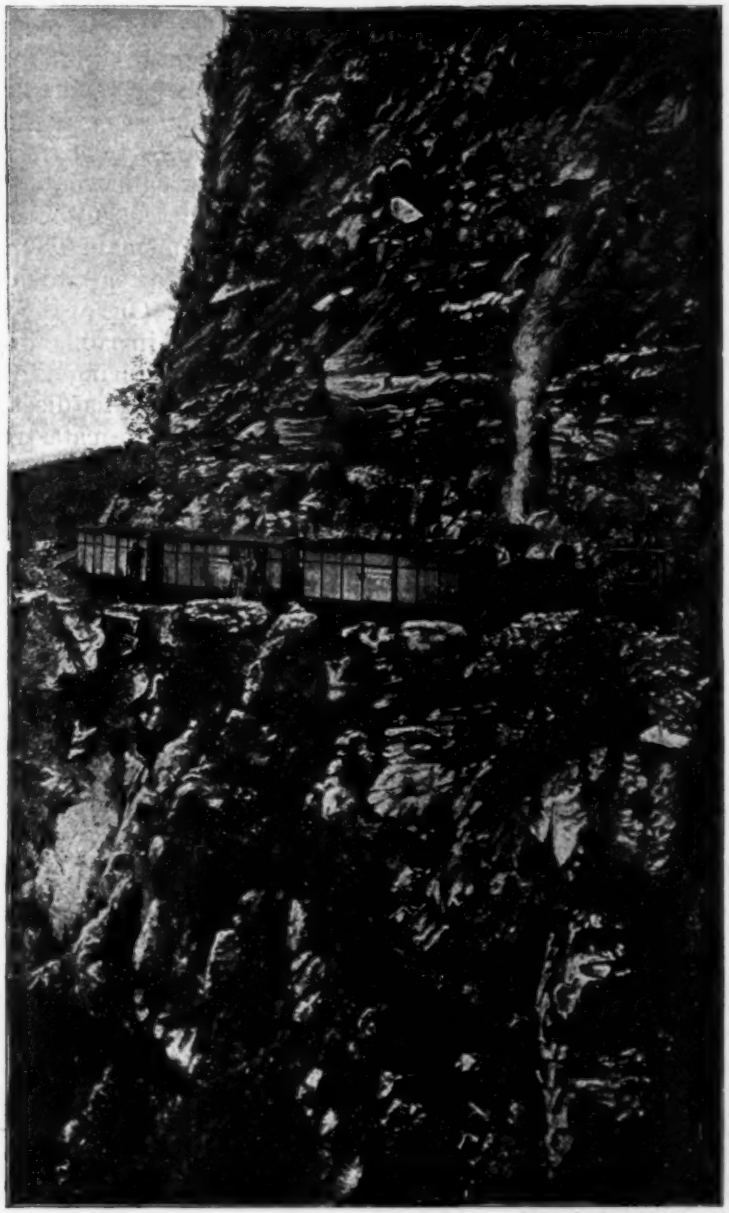
Lake Dwellings of Santa Rosa, near Maracaibo.

supplies the neighboring city of Merida with ice. Low chains also stretch along the coast as far as the delta of the Orinoco. These mountains for the most part run in parallel ranges, between which lie elevated valleys. In these valleys are most of the cultivated lands of the country. Here also are the chief cities, although many of the seaports are of considerable size. Carácas, the capital, is nine miles back from the coast, at an elevation of three thousand feet, but the railroad which runs to it from La Guaira is obliged to take a tortuous way of twenty-three miles, passing through many cuts and tunnels. There are no stations along the route, and the country is not cultivated except near the termini. In many places the track winds around a mountain on the verge of a sheer descent of hundreds of feet. Carácas lies in one of the mountain valleys, which slopes toward the south and is traversed by the Guaire River. Its temperature is equable; the mean of its coldest month, January, being 68° F., and of its hottest month, May, being 93°. Rain falls abundantly in April, May, and June, though not so constantly as in other tropical regions. The rest of the year is rather dry.

Between the mountains and the Orinoco stretch the broad llanos or grassy and partly tree-covered plains which form the basin of the great river on the northwestern side. The extensive, thinly populated territory south and east of the Orinoco is made up of alternating hills and valleys, and is heavily wooded. This region has some mountains of moderate elevation, among which is Roraima, of much interest to explorers, standing on (or near) the boundary of British Guiana. Its tablelike upper portion, a mass of pink sandstone rising sheer sixteen hundred feet, was first ascended in 1884 by Im Thurn and Perkins after many unsuccessful attempts had been made. "Obviously Roraima was formerly," says Reclus, "part of an elevated table land, which has been gradually isolated by a process of cleavage and erosive action. It survives to present times as a superb witness to former geological conditions. Streams have their rise on the upper platform, over the edge of which they fall in cascades, draping the pink escarpments as with lace veils of their silvery spray. 'O Roraima, red mountain, wrapped in clouds, fruitful mother of streams!' sing the Arecuna Indians encamped in the surrounding valleys."

Venezuela has no volcanoes, but traces of ancient eruptions are to be found among the highlands. Certain flames often seen hovering over the ground were formerly thought to be connected with subterranean fires, but this idea has been dispelled by advancing knowledge. "This curious phenomenon," says Reclus in his description of it, "has been noticed on the slopes of Duida, on Mount Cuchivano, in the province of Cumaná, and in the marshy valley of the Catatumbo and of other streams flowing to Lake

Maracaibo, where it is known as the 'lighthouse' or 'lantern,' because it indicates to mariners the position of the land. Flames



SCENE ON THE RAILWAY FROM LA GUAIRA TO CARACAS.
(From Around and About South America, by Frank Vincent.)

are also frequently seen flitting about amid the grasses of the llanos without burning them. These are 'the fire of the tyrant

Aguirre,' say the natives, who, after more than three hundred years, are still haunted by the legends associated with this sixteenth-century corsair. The vapors rising from certain asphalt lakes similar to that of Trinidad are also said at times to be subject to spontaneous combustion." It might have been well if there had been a few active volcanoes in the country during recent times. Venezuela has suffered some terrible earthquakes, and on the theory that these disturbances are due to pent-up underground forces, the existence of natural vents would have prevented them. In 1550 an earthquake occurred, accompanied by a tidal wave, which swept away the settlement of Cumaná, and the same place suffered severely in 1766, after which the ground continued to tremble for fifteen months. One of the most destructive shocks, by which Carácas was laid in ruins with a loss of twelve thousand lives, occurred in 1812, during the war for independence. "The indirect consequences of this disaster," says Reclus, "were even more deplorable than the catastrophe itself. It certainly prolonged the ruinous war probably for years, and greatly intensified its horrors. The event having taken place on Holy Thursday, the anniversary of the declaration of independence, the priests, nearly all of whom belonged to the Spanish party, declared that the hand of God had wrought the ruin in order to crush the revolution." Thousands of superstitious revolutionists, including Miranda, the general in chief, laid down their arms, and the Spaniards secured fortified places and other advantages that were recovered only at great cost.

In a country so much upheaved a variety of minerals will naturally be found accessible. There are rich deposits of gold in the region east of the Orinoco bordering on British Guiana, which accounts for the ownership of part of that territory having been in dispute for half a century. The famous mine El Callao has yielded over three million dollars a year. Its upper levels have been pretty well worked out, so that its present output is secured by deep mining operations. As an export, gold ranks next after coffee and cacao. Considerable copper ore is exported, mainly the product of the Aroa mines in the Maritime Alps, near the northern coast. Lead and tin are also found. If Venezuela owned all the islands that lie off its coast it would have an important source of mineral wealth in the famous asphalt lake, La Brea, on Trinidad. But Trinidad and Tobago had been taken from Spain by Great Britain, while Curaçoa, Buen Aire, and Oruba had been appropriated by the Dutch, before Venezuela secured its independence. The mainland, however, is by no means devoid of bituminous deposits—asphalt, petroleum, jet, and bituminous coal being obtained in various localities. Other useful minerals found are sulphur, kaolin, and phosphate rock. Margarita, the largest of the islands belong-

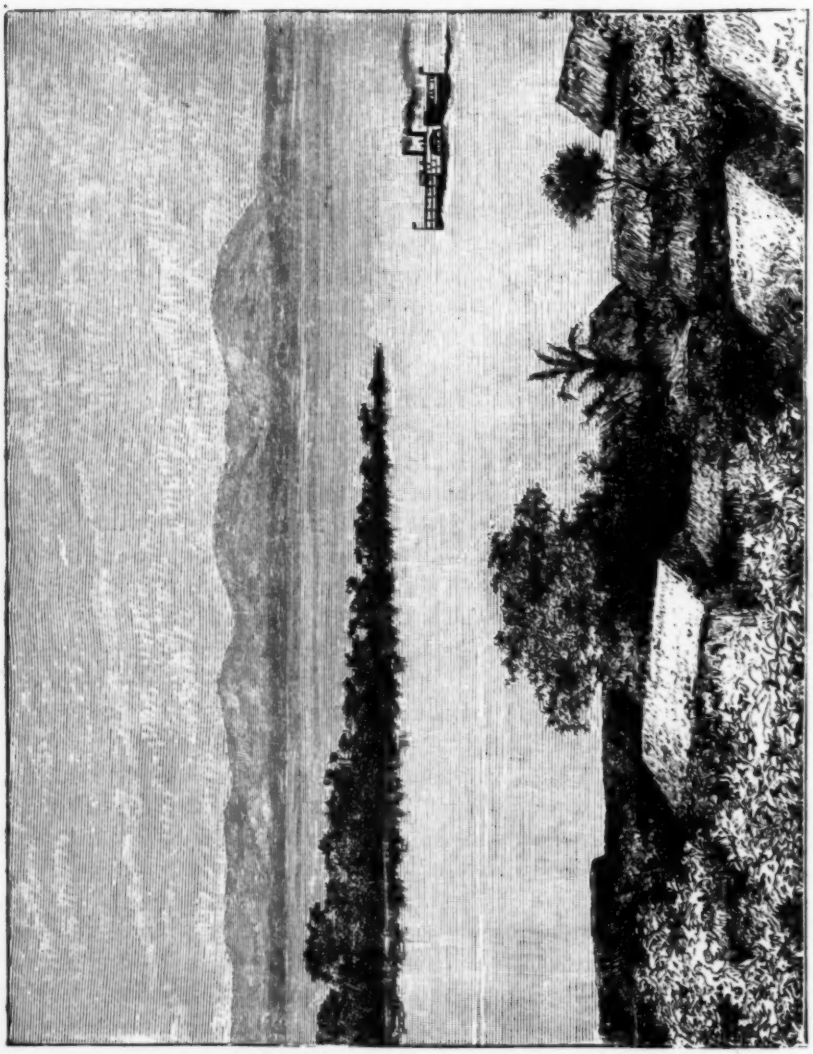
ing to Venezuela, is the seat of a pearl industry that was once important but has seriously declined. Its fisheries are flourishing, but these, together with the scant agricultural resources of the island, do not suffice to support the native population, which increases rapidly. Consequently, large numbers of the men emigrate to the mainland. The climate of the island is salubrious and attracts consumptive patients from great distances. An excellent quality of salt is produced on all these islands and along the coast of the mainland. From a lichen growing on the rocks of Orchilla is extracted the violet dye of that name.

While in the United States the Indians are an almost unregarded remnant, the aborigines of Venezuela form a large element of the less than two and a half million population. The pure whites, mainly of Spanish origin, but including immigrants from the chief trading countries, are less than two per cent of the whole. The pure aborigines are estimated at about one seventh, and there are some negroes, as African slavery existed here up to 1854. Parts of these races have intermingled in various ways, producing mestizoes, mulattoes, zambos, and mixtures of other degrees. Four fifths of the full-blooded Indians are classed as civilized, and are engaged in agriculture, or as laborers in the other occupations carried on by the whites.

The climate of different parts of Venezuela varies greatly with elevation, aspect, and soil. The highlands are in the main temperate and salubrious, while the low parts of the coast, the lands about Lake Maracaibo, the delta of the Orinoco, and parts of the plains are among the hottest regions in South America. During the rainy season, from April to October, many of these low lands are flooded, giving rise to swamp fevers and dysentery. The country does not suffer so much from yellow fever as might be expected.

The downpour of the rainy season is drained away by over a thousand rivers, many of which become dry or dwindle to chains of lagoons in the dry months. The Orinoco is the great artery of the country and is destined to become of vast importance as a channel of traffic when the region through which it flows is more thickly settled. Steamers enter it from the sea by seven of its fifty mouths, and run to Bolivar, three hundred and sixty miles up the river. Smaller steamboats can ascend as far as the Atures rapids, nearly a thousand miles. Its chief branch, the Apure, gives access to a region far west of the main stream, and, as some four hundred of its other affluents are said to be navigable, it will be seen that a vast extent of country is reached by the Orinoco system. In this respect, which is the true measure of a river's importance, the Orinoco ranks fifth on the American continent, or fourth, if we disregard the artificial helps with which the St. Lawrence has been provided. Just below the great bend of the

river, two hundred and fifty miles above Bolivar, is the smaller town of Caicara, which is also an important trading station. Here manufactured goods are exchanged for the products of the forests and plains. Mr. Frank Vincent thus picturesquely describes the voyage up the great river:



THE ORINOCO AT CAICARA.

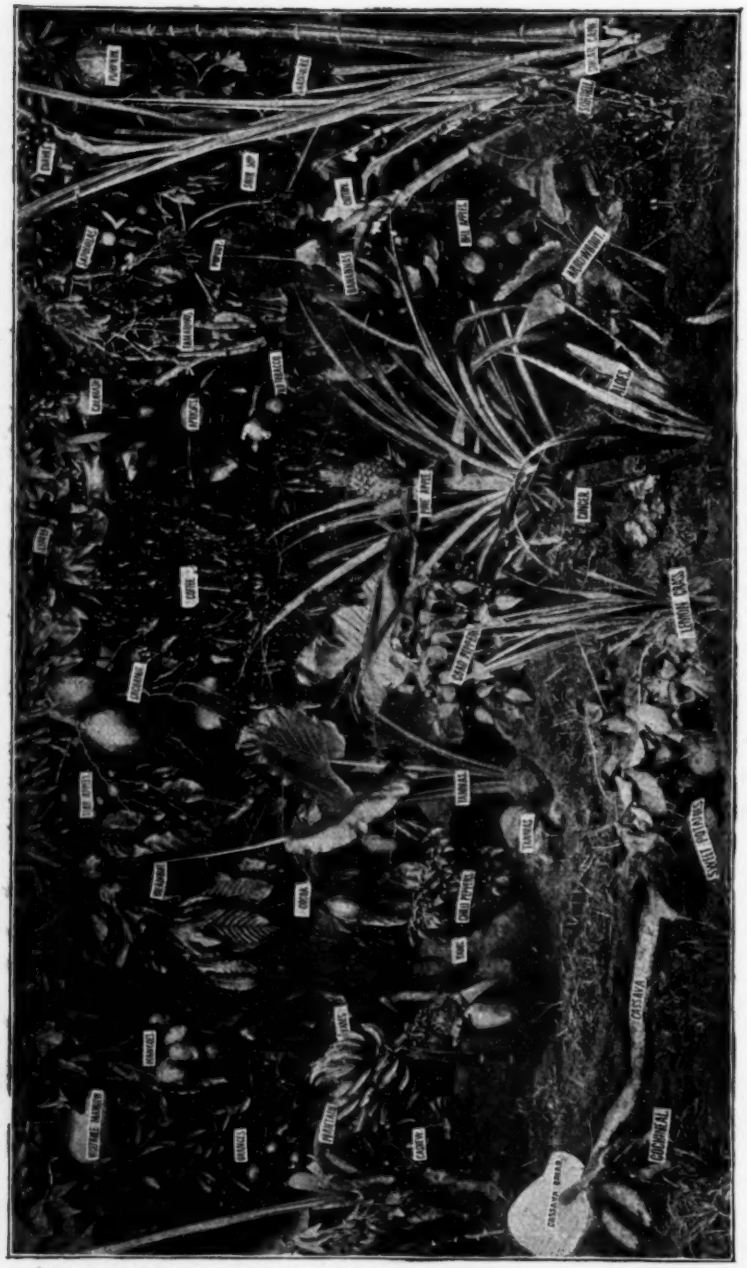
"On leaving Port-of-Spain we headed at once toward the southwest and the Serpent's Mouth, out of which we safely passed and entered that branch, or rather that one of the many great mouths of the Orinoco styled the Macareo River, which was at first about half a mile in width, its shores densely covered with aquatic plants and forests. Running nearly parallel to this river

is another called the Casquina. Both are navigable for steamers drawing less than ten feet; those requiring deeper water than this must use the southern and main branch of the Orinoco. This one is naturally always preferred by ships. The water of the river is a thick yellow, and the current is as swift as four or five miles an hour. As we went on all day, the Macareo narrowed to about one hundred feet, but was very deep. The banks appeared quite uninhabited until we reached the Orinoco proper. First we passed two very small Indian villages. The houses consisted merely of grass roofs and wooden pillars, being quite open on all sides, and disclosing numbers of hammocks each containing a nearly nude Indian. Near by were fields of mandioc and bananas. On the beach small pirogues were drawn up. At one place some of the boys paddled out to us, and in wanton sport threw on board many sticks of sugar cane. These Indians had stout, strong bodies and broad and good-natured physiognomies, with their hair 'banged' across the forehead and left long at the sides.

"In its vast size, and large and numerous islands, the Orinoco is not unlike the Amazon, but the banks differ from the Amazon's chiefly in their greater profusion of lianas, the forests being not only decked but half covered with them. After the Indian villages, we passed, upon the Macareo, long lines of widely separated mud huts, belonging to negroes and low-class creoles. All these people wore clothes, had a variety of cooking utensils, and better dwellings than the pure Indians. Near where the Macareo enters the main branch of the Orinoco is a small town called Barrancas—simply two short streets of dilapidated mud huts. We stopped only ten minutes to send our boat ashore with the mail, and to bring on board two or three passengers. Some very large islands invite the view hereabout, and the distant ranges of the Imataca Mountains, ridge behind ridge, look blue and picturesque. The current of the Orinoco does not carry down the great number of grassy islands and tree trunks that one sees always on the Amazon. . . . A fine spectacle at night were the many great prairie fires, the whole sky being aglow with them. A certain fire would suddenly appear, tearing along at a terrific rate, with a blinding glare and long trail of smoke, recalling a night express train a thousand times magnified. The Venezuelans are accustomed to burn their savannas once a year. We had already left the regions of the pristine wilderness, and were now among the great savannas, or natural meadows of the central plains of Venezuela. The delta is the only thickly wooded part of the Orinoco, the upper portion of the river being bounded by the llanos, or great grassy and almost treeless plains."

Near the head waters of the Orinoco is its junction with the Cassiquiare, by which it has a navigable connection with a branch

of the Amazon. The stream forming this curious bond between two great river systems lies in a valley which is prolonged south-



VEGETABLE PRODUCTS OF VENEZUELA.
(From Around and About South America, by Frank Vincent.)

ward by that of another river. About one third of the water that it sends down to the Amazon is obtained from the Orinoco.

The chief wealth of Venezuela consists in products of the soil, natural and cultivated. There are many coffee and cacao plantations in the mountain valleys near the coast, and coffee to the value of fourteen million dollars is exported yearly, which is double the value of all other exports. Among the other cultivated articles are manioc, sugar, cocoanuts, maize (Indian corn), tobacco, wheat, cotton, indigo, sweet potatoes, and melons. Canoes which ascend the upper Orinoco and its branches to the forested region of the southeast bring down rubber, vanilla and tonka beans, fruits, gums, and drugs. The forests are also rich in cabinet and dye woods, useful fibers, from which cordage and hammocks are made, and a variety of other products. The deadly arrow poison called *urari* by the natives is made in the district south of the Orinoco.

The central plains of the republic form a vast grazing range which supports millions of horned cattle, horses, and asses. These herds are subject to great vicissitudes; they were reduced to a small fraction of their normal size by the war for independence, and again by the civil wars ending in 1863, while vast numbers of horses and asses were destroyed by a murrain which broke out in 1843. Their numbers have, however, been restored, and the stock has been improved recently. Sheep and goats are bred in the mountainous district of the northwest, whence goatskins (known as Curaçoa kid) are largely exported.

The animal life of the forest is varied and abundant. The howling ape makes his presence known morning and evening to all within earshot, and fifteen other simians are met with. The representatives of the cat tribe include the jaguar, puma, and ocelot. There are also harmless bears living on fish and honey, the ant-eater, the cavy, the cuchi-cuchi, the tapir, various species of deer, and the slothful sloth, which, as Reclus says, "after devouring the foliage of a cecropia, utters long, plaintive cries at having to climb another." Myriads of birds of brilliant plumage vie with the tropical flowers to enliven the somberness of the forest. The waterfowl are no less numerous; it is said that a regiment, encamped near the confluence of the Apure River with the Orinoco, lived for a week on wild duck without appreciably reducing their numbers. One of the curiosities of Venezuelan bird life is the *guacharo*, a night-flying fruit-eater which inhabits caves in certain of the coast districts. Its fat yields a much-prized table oil.

Both the salt and fresh waters of the country abound in fish. Sixty-pound turtles are abundant in the large rivers, but will not long continue so unless the taking of their eggs is limited. Three species of alligators are found in the rivers and lakes, while the manatee and porpoise enter the Orinoco from the ocean. The

electric eel also inhabits Venezuelan waters. Certain streams of the Apure district are carefully avoided by bathers, less through fear of the alligators than of these eels and other electric creatures, and of the ferocious fishes called caribs, after the once-dreaded tribe of cannibals. The last so abound that some creeks are said to contain "more caribs than water."

Noxious creatures are not wanting on land. Many snakes glide through the herbage, especially on the plains, among them being the anaconda, the boa constrictor, and the striped rattlesnake. The swampy islands of the Orinoco delta swarm with mosquitoes, and at the Maipures rapids, where "the wind never blows," the air sometimes seems to be full of them. Locusts are often a great plague to the peasants.

Venezuela is a country of great resources, with some obstacles in the way of utilizing them. Not all of its known useful minerals have been mentioned here, and a thorough geological survey, which the country has never had, would doubtless largely extend the list. Nor are its forest products by any means completely known. The future prosperity of the land requires self-control and energy on the part of its citizens, with regulations to induce the foreigners who go there to become Venezuelans instead of withdrawing a portion of its wealth to be enjoyed after returning whence they came.

SUGGESTIBILITY, AUTOMATISM, AND KINDRED PHENOMENA.

By Prof. WILLIAM ROMAINE NEWBOLD.

III. DISORDINATION AND INCOORDINATION.

IN my two former papers I have sketched the conception of any state of consciousness as a coordination of mental elements which might conceivably exist independently, and have endeavored to bring it into relation with our conception of the physical basis of consciousness as a similarly coordinated system of forces to certain elements of which the various discernible elements of consciousness in some sense correspond; and I have drawn from this fundamental conception two inferences; (1) That we must think and reason about the mental thing as we would about its physical basis; we must therefore ascribe to it dynamic properties which will in the long run be found correspondent to the laws of brain-functioning. (2) It is conceivable that a cortical process might exist without coalescing with any such system as underlies a personal consciousness, and that a mental state might exist in connection with the process out-

side any consciousness whatever. We can not, however, logically stop at this point. If a single cortical process and its concomitant mental state may be dissociated from others, there appears no *a priori* reason why many may not be simultaneously dissociated, nor yet why the entire system may not be dissolved and reduced to a chaotic mass of physical processes and concomitant mental states. For such a supposititious condition I would propose the term *disordination*, the etymological opposite of coordination. We may well believe that if a disordinated state occurred it would not be remembered. Memory depends, from the psychological point of view, upon the law of association, and from the physiological upon the fact that between the cortical processes underlying the present state of consciousness and the traces left in the cortex by those accompanying the state remembered, there is a continuous system of traces, representing actual processes that discharged successively into one another. In a disordinated state there is no such continuous system and consequently no memory. But it is also conceivable that, from a present state succeeding a state of disordination, a single devious thread of traces, so to speak, might lead us back a little way into the maze of confusion which lies behind. As I shall later show, our memory of a dream depends upon such a line of continuous discharge.

In a disordinated state the dissociated elements would not of course be what they would be in a well coordinated state. In the latter the characteristics of each element are largely determined by the relation which it bears to other elements of the system with which it is interwoven. Freed from the restrictions and incitements of the others, each process would tend to work out its own proper results in a very different way from that which it would otherwise have been compelled to follow.

Furthermore, it is conceivable that co-ordination might be defective without being absolutely lacking. I would term this *incoördination*. It might occur in either of two forms, or in both at once. The coordinated system underlying the upper consciousness might consist of relatively few elements as compared with those of other persons, there being a larger subconscious field. The upper consciousness would then habitually be narrow; the individual would be unable to grasp many considerations at once and would be easily abstracted. Or, the elements actually coordinated might be defectively coordinated. The consciousness would tend to be confused, the individual would see dimly things which would persistently refuse to get clear, and would be in general what we call "muddle-headed." And, as I have suggested, many are both muddle-headed and narrow-minded.

It is evident that the distinction between disordination and

incoordination, is merely a question of degree, and it will frequently be difficult to assign any given concrete case to either the one class or the other.

So much for the logical analysis of the hypothesis we are considering and its implications. If we turn now to the facts and try to apply these principles to them we shall find, I think, that many phenomena for which our current psychology can not give any explanation, become, if not entirely intelligible, at least more comprehensible than they were.

A familiar form of disordination is found in states of which sleep may be regarded as the type. Perfect sleep is not a disordinated state. In perfect sleep we must suppose that all mental life is absolutely quenched; not even isolated states remain. But most sleep is not perfect, and it is probable that some cortical activity persists throughout. When we would go to sleep we withdraw ourselves as much as possible from the storm of stimuli that is always assailing our sense-organs, thus cutting off all vivid sensations with their complex and far-reaching associations. Little by little the activities that remain—i. e., those that lie at the foundation of our ideational life—become quiescent. Then the laggards among them, freed from their usual restraints, assume distorted forms. Isolated scenes, dislocated scraps of sentences, vague thoughts, flit through the mind's rapidly emptying chambers, coalescing and combining with one another in fashions grotesque and unpredictable; from moment to moment they become fewer, and then—oblivion. Sometimes on awaking we remember strange experiences had in sleep—what we term dreams. What are they but dislocated systems of mental elements, sometimes springing out of elements which have persisted through the period of disruption, as when we dream of things with which our thoughts have been busied through the day, sometimes springing out of sensations occasioned by stimuli falling upon our sense-organs. Yet in every case dreams are developed under associative laws analogous to those of waking life, although very different in the details of their operation. Take the case M. Maury reports. He got a friend to tickle his face with a feather while he was asleep, and dreamed that he was being tortured by having a mask of pitch applied to his face and then torn forcibly away, taking with it the skin and flesh. Had he been awake, the stimulus would have caused a sensation of tickling; by associative reasoning he would have instantly divined its cause, and would have thought of the movements suitable to stop it. In sleep the sensation developed far more than it would have done in waking life, and was therefore magnified into an intense tearing sensation, and for this magnified state by similar associative reasoning a suitable cause was found. Had he been awake, even if

the sensation had succeeded in developing, the least suggestion of torture as an explanation would have been quenched by a mass of inconsistent ideas. In sleep the grotesque notion finds no obstacle to its acceptance. Who has not dreamed of himself as being in some public place and then suddenly become aware that he is naked and exposed to the gaze of the crowd? What is this but the coalescence of the sensations arising from his actual state as he lies in bed with the thought systems representing his imaginary experiences?

If one puts a man asleep and all the while keeps talking to him, touching him and otherwise keeping him aware of one's presence, one gets in many cases a peculiar type of sleep known as a hypnotic state. We may suppose that all the elements composing the man's normal consciousness are disordinated and for the most part extinguished, but the one group which he calls the consciousness of the presence of his friend Smith who is hypnotizing him still remains. That has no chance to go to sleep, as it were, and consequently in his disordinated brain all processes originated by that one still active group tend to work out their normal results with a precision and certainty unknown in waking life. He is either totally dead to all other stimuli, or can be made aware of them only with difficulty. Frequently the attempt to force such a stimulus upon him is followed by great nervous excitement, somewhat like that which usually follows a great shock or surprise. This is, I think, the true character of the suggestibility found in hypnotic states and of the so-called phenomenon of *rapport*.

Another common form of disordination is that which accompanies a "nerve storm." We know that if a mass of heated and moisture-laden air begins to escape into the upper and colder regions of the atmosphere at any point, the upgoing current, no matter how slender at the outset, may increase in volume and velocity until it develops into a vast storm center hundreds of miles in extent. So also does it appear that a relatively small and localized nerve explosion is capable, under conditions which we do not at all understand, of propagating itself irregularly through the nervous system, ignoring the usual association paths, until the entire nervous mechanism is exhausted. Such a progressive, periodic disturbance is said to be epileptiform. The causes of the various forms of epilepsy are often unknown. Some, however, are due to mechanical irritation of the cortex, as by a depression of the skull, an extravasation of blood, disease of the membranes, or the growth of a tumor on the cortex. Others are produced by some continuous and intense peripheral irritation, as that springing from an unhealed wound, an ingrown nail, etc. Others still are due to the memory of some great shock or fright, and

we may suppose that the subconscious memory of that experience is capable of becoming from time to time strong enough to disturb the coordination of the upper consciousness. Indeed, most of these causes may produce chronic incoordination without going so far as to destroy coordination altogether. Now, all these cases may be generalized under one conception. In my first article I compared the system of activities underlying consciousness to the system of forces upon which the existence of the soap bubble depends. We all know that the introduction of any new and intense factor into that system, as when one pricks the bubble with a dry pin, instantly destroys it. It would appear that much the same is true of the system of cortical activities.

The precise effect of the nerve storm upon consciousness, however, varies with the region upon which its force is chiefly spent. In the so-called masked epilepsies or periodic insanities consciousness is directly affected, and with greater or less severity, but the complex disturbances so produced can not be reduced to definite classes. New elements are introduced, old elements are destroyed, or weakened or intensified, as the case may be, and the character temporarily modified. Whenever the disturbance is very great, however, memory is more or less impaired, as our theory would lead us to expect. In the true epilepsies the violence of the storm is expended upon the motor region, producing movements, sometimes of a purposive character and sometimes not. Whenever the storm is at all severe, consciousness is disordinated and no memory remains. After the storm is over the patient sinks into a state of true unconsciousness, and often he recovers from it but slowly, passing through stages of automatism as the elements of consciousness slowly find one another and are built up into a system. If you question him after his recovery, he says he was unconscious the whole time. But we have reason for believing that during the period of convulsion mental states—such as muscular sensations, sensations of pain, and probably horrible dreams and nightmares—really existed, while in the comatose state there was nothing of the kind. The first was a state of disordination; the second, of true unconsciousness.

The symptoms of incoordination are, as one would expect, of infinite variety and incapable of classification. It is known in medicine as hysteria, and I can say but little of it here.

In its simpler forms there seems to be a general inability to think of much at once. Consequently, what is in consciousness is very much there, to use a colloquial phrase, and tends to work out its own results. The patient is easily abstracted, fails to notice things, is narrow and prejudiced. In practical matters he has bad judgment, for good judgment implies the ability to weigh many considerations at once. It is difficult to convince him of a

new point, but, once convinced, there is no length to which he will not go in its application. At any given time he is a man of one idea, given to a fad, and very apt to be zealous in reform movements of all kinds. He can rarely discriminate the probable from the possible, and consequently can never think of a disaster without fearing it will come to pass. This is especially true of his own health. If he reads a medical book or a patent-medicine advertisement, he discovers in himself the symptoms of most of the diseases of which he has been reading. In a person of this temperament any great shock is apt to bring on a state of disordination with concomitant derangement of the motor coordination—what we vulgarly call a "fit of hysterics."

In more serious cases the indisposition to notice things goes further and often culminates in absolute inability to perceive what a normal person would. Entire systems of sensations may be wholly or partly lost. Touch is the sensation most frequently lost in this way, although sight and hearing sometimes go too. Very frequently sensation is lost on one side of the body only. The control exerted by the idea trains over the movements of the body is also partially or wholly lost and the patient is paralyzed. Hysterical losses of this kind are often cured by suggestion, or by any means in which the patient has faith. In the most extreme cases the patient passes hours, days, months, or even years in a state of apparent lethargy, which is probably a chronic disordination.

With the retrenchment of the field of consciousness goes hand in hand a corresponding increase in the subconscious field, and the elements dissociated from the upper consciousness frequently appear to become coordinated with one another, forming subconscious systems analogous to the upper system. They are then sometimes manifested to the patient himself by being obtruded upon the upper consciousness in the form of inner voices, hallucinations of sight or hearing, etc., or to other persons by means of movements. Occasionally they go so far as to produce writing in which the upper consciousness of the patient has no part. Hence arises for outsiders the appearance of two minds existing in one body, while to the patient his body seems to be running like a machine, without his cooperation. All such phenomena may be termed automatic, and upon them the popular belief in "spirit control" and "demoniacal possession" undoubtedly largely depends. When automatic phenomena are numerous and complex, the upper consciousness of the patient is usually profoundly affected. He sinks into a dreamy state, and often loses "consciousness"—i. e., memory—altogether. "Mediumistic trance" may then be regarded as a form of disordination analogous to that of the hysterical crisis.

In some of these unfortunates the upper consciousness is not only of very narrow range and liable to frequent disordination, but is of such unstable composition that, after being disordinated, it is reconstructed out of a quite different set of elements. Mr. F. W. H. Myers has proposed to call this phenomenon an "allotropic crystallization" of the elements of mind, which seems to me a highly appropriate simile. The patient can then scarcely be said to have any permanent self at all. He is, as it were, broken to pieces and rebuilt out of different memories, desires, and aptitudes at every hysterical crisis. It seems as if his body were successively possessed by totally different persons. But we have no reason for believing that the different persons all coexist. Probably the emergence of one is only made possible by the destruction of another. In some of the extreme forms of hysteria it is possible to take advantage of this principle to reconstruct the lost normal individual. Pierre Janet has taken a hysterical woman who had lost many of her memories and sensations, and to some degree her power of movement; disordinating the upper consciousness by hypnotizing her, he has grasped, as it were, by suggestion the lost mental elements, restored them to the upper consciousness, and made her for the time being quite normal. But, unfortunately, the enlarged upper consciousness seems of very unstable composition, and the patient soon sinks into trance and awakens in her former state.

I have briefly outlined this conception of consciousness as a system of elements capable of disintegration and of various novel recombinations. And let me repeat what I have already said, that although I have preferred, for the sake of brevity, to develop it deductively from certain fundamental hypotheses, it has been attained by the opposite process from a study of facts. Confessedly it is as yet only a theory, and will doubtless be essentially modified before being accepted as the foundation of the science of psychology. In its present form I can not myself regard it as more than a good working hypothesis. But it is something to have even a good working hypothesis in a field in which the constructive conceptions of current psychology prove absolutely useless.

A GREAT nebula has been discovered by Prof. Barnard in the constellation Scorpio, including Antares and a region extending two or three degrees southward. It is described as vast and magnificent, intricate in shape, and gathered in cloudlike forms. Prof. Barnard pronounces it one of the finest nebulæ in the sky, and says that, as it involves so many of the bright stars of the region, it would imply that they are essentially at the same distance from us.

THE STAMPING OUT OF CRIME.

By Dr. NATHAN OPPENHEIM.

IT is only a short time since civilized nations abolished slavery, and already we look back with wonder at our own and other countries, and are barely able to realize that the world could have borne such an unspeakable institution—that it could have steadily progressed while weighted with the breaking load of such a burden. Nevertheless, for thousands of years, and even at times of exquisite culture, men thought that slavery was inevitable, or even necessary, or at any rate that it could never be done away with. Now there is an equal steadfastness of opinion in the opposite direction. We regard with horror the social condition which justified bondage; we are astounded that we could have lived in such an atmosphere.

There are other similar examples in the history of civilization. Until the present century drunkenness was almost universal, and the gentleman who did not drink himself under the table was thought at best to be a poor sort of man. Our present attitude in the matter is just as great a revolution as our change in regard to slavery. Likewise is there an equally great difference so far as the interests of society are concerned. Again, until the middle of this century there was a constant succession of wars among the principal nations; but within a few years conditions have so changed that the man who dared to precipitate a war would be utterly overwhelmed with universal abhorrence.

If we look into the future, we may see as great a change, which is beginning to assert itself in regard to the necessity of crime. Indeed, the above analogies are well carried out, from the fact that so many people at present think crime is inevitable—that because society has always sweated under this burden it follows that the burden must ever be carried. On the contrary, because society has always been oppressed with crime there is good reason to suppose that changed conditions must alter the present facts, and that we may look for a season when crime as a constant and unvarying social element will have ceased to exist; when it will show itself in minor and individual cases, as drunkenness is beginning to do, as plagues and epidemics are beginning to do.

One of the best indications for hope is the growing effort to study crime accurately; not merely to regard it as an excuse for confining lawbreakers in self-infecting herds, where they may undisturbed pollute one another, but, on the other hand, to seek for the causes of crime, to ascertain all its concomitant conditions, to recognize and classify the criminal in sociological, psychological ways—in the ways of anatomy and physiology. The

recent congresses for this object in Paris, Rome, and Brussels have opened a new world of information, have shown how misty have been our ideas on the subject, how primitive our methods have been and are, and what little hope for the future lies in a continuance of them.

This much, at least, we have learned: that the criminal forms a class by himself, no matter whether he is born so or grows into vice; that not only in his acts but likewise in mind and body does he vary from the healthy normal. For his tendency, as that of all organic life, is to reproduce his kind. This fact should be regarded as a rule that is as widely applicable and as unvarying as any law of biology. It can not be otherwise, for every child is a summing up and a manifestation of the traits of his ancestors. And so, in spite of our present efforts, each confirmed law-breaker becomes an ever-fruitful fountain for wrong—a moral plague spot—the limits to whose contagion are bounded only by the amount of material that can be contaminated. The most superficial glance will show how true this is, for if it were otherwise one would rightly suppose that the vast efforts for social amelioration throughout society must surely result in an increase of the better and a decrease of the worse elements. But as a matter of fact this is not the case. We spend tremendous amounts of time and money and effort in the attempt to eliminate the need of crime; we strive to the last extent to do away with destitution, unsanitary conditions, ignorance, and depressing moral influences, and undoubtedly these efforts have accomplished much good. But in spite of all this, in spite of aid societies for discharged convicts, in spite of educational possibilities that are as free as air, in spite of college settlements, protecting associations for children, reformatories, and lavish charities of all kinds—in a word, in spite of vastly improved social surroundings—the criminal remains as he has always been. Crime does not lessen, but on the contrary increases with the growth of our cities, or even increases beyond the proportion which we should naturally ascribe to it.

The strange thing about all this is that the development in crime does not necessarily depend for its beginning and growth upon the elements which are popularly held responsible. Many people believe that with the wider diffusion of knowledge wrong-doing must necessarily shrink away—that mental enlightenment and moral darkness are incompatible. But this is merely a supposition, for the most part based on our admiration for education. And, as a matter of fact, concrete examples constantly remind us that the educated person, if wrongly minded, does not as the result of his mental training become a law-abiding citizen, but rather becomes a dangerous and capable criminal. Moreover, this

is true not only of individuals, but also of masses as well. We have to prove it the statistics of Dr. Ogle, in regard to the English population at a time of a steady increase of crime: "Eighty-five per cent of the population were able to read and write in the years 1881–'84, and as this represents an increase of ten per cent. since the passing of the Elementary Education Act, it is probably not far from the mark to say that at the present time almost ninety per cent of the English population can read and write. In other words, only ten per cent of the population is wholly ignorant." In spite of this general diffusion of knowledge, in spite of compulsory education in the most critical and formative years of childhood, there was no decrease, but on the contrary an increase of crime.

Again, it has been conclusively proved that destitution, that specter which frightens the hearts of men, which covers and obscures with its sodden wings every wrongdoing in human life, is not in any way the real cause of crime; it is true that often it is the excuse. But it is only the excuse, and even in that capacity it serves for the want of something better. However, relying upon this excuse, one would naturally think that men with the greatest burdens would be the most liable to lawbreaking, and that times of profound destitution would be those most deeply marked with crime. As a matter of fact, both of these suppositions are false, so that we find criminals, as a rule, to be those persons having almost no responsible burdens, and, strangest of all, the times of prosperity show the greatest flourishing of crime. Therefore, Morrison, a reliable writer, says: "It is a melancholy fact that the moment wages begin to rise, the statistics of crime almost immediately follow suit, and at no period are there more offenses of all kinds against the person than when prosperity is at its height." Again: "It is found that the stress of economic conditions has very little to do with making these unhappy beings what they are; on the contrary, it is in periods of prosperity that they sink to the lowest depths."

In like manner it can be fully and plainly proved that the other fortuitous and external conditions which are usually blamed for the wrongdoing in the world are either quite innocent or merely accidental. Thus, climate is said by some to be a guilty factor; but we all know how easy it is to show that there is no part of the world untainted. Seasons are responsible, say others. Here, again, a strange fact confronts us: for it is in the pleasantest seasons of the year, when people have least in Nature to contend with, when they are most abroad and mingling together, that crime is commonest. Some well-intentioned men say that certain foods, especially "strong" and animal foods, so inflame the tendency to viciousness that evil instincts flare up, and as a

result we have the criminal. It is quite unnecessary to spend time in exposing this fallacy in physiology; we need only refer to the Italians, whose food is very largely vegetable, and whose percentage of crime is among the greatest. The native inhabitants in India are another case in point; for their diet is likewise almost entirely a vegetable one, and yet, if it were not for the interference of the carnivorous English, they would even now be addicted to the almost universal practice of infanticide. So also is it that social rank, while setting metes and bounds in every other direction, fades away in the domain of evil. The criminal may be high or low, he still is the criminal; and, reasoned about broadly, there are as many offenses among the socially exalted as the socially debased.

Thus from every side we are driven away from the fortuitous, the occasional, the accidental as the controlling cause. We are forced, as a necessary resort, to something more reasonable, more stable, something which we can work on and understand. And as soon as we look on the matter with such eyes, it becomes plainer, more tangible, holding out hopes for amelioration if not entire cure.

In a problem like this, which has so many ramifications, we should seek for constant factors of divergence from the normal; or, better still, let us decide what is the healthiest development, so that we may be better able to understand the abnormal, the deficient in human character. "The perfection of man," says M. de Laveleye, "consists in the full development of all his forces, physical as well as intellectual, and of all his sentiments; in the feeling of affection for the family and humanity; in a feeling for the beautiful in Nature and art." Now we have something really definite. We have a clear idea of what is essential to the highest growth of human worth, and immediately we recognize that in the criminal we have a being more or less utterly removed from this standard, and thus representing what is abnormal, twisted, or diseased. What is more, this divergence is a constant one, which reproduces itself over and over again in successive generations of wrongdoers. It is rarely necessary for a man to commit crime at the present time, even though he be laboring under adverse circumstances; and it is never necessary for him to continue such a career. Therefore, when he does, it is a matter of choice or of temperament. Very often the amount of ingenuity and talent exhibited would be sufficient, if rightly applied, to bring him comfort if not greater rewards in the regular lines of effort.

The majority of us exhibit a strange lack of logic in thinking about hereditary transmissions. We recognize the necessity of breeding and the duty of selection in regard to animals; we are

perfectly willing to follow well-known ideas on the need of weeding out undesirable traits in cattle; moreover, the world has for a time shown its belief in the existence of hereditary genius, otherwise Galton's painstaking work on the subject could never have reached its present popularity, nor should we now possess our admiration for "good blood." But when we speak of the more unfavorable traits and the deadly certainty of their reproduction in descendants, our lips falter, we quickly hide the unpleasant sight with a capacious covering of charitable forbearance. We constantly meet with startling examples of transmitted crime, such as the famous or infamous Cook gang and Jukes family; every day in the more unfortunate phases of metropolitan life we see children following in the wake of parents and grandparents in the wide sea of vice; even do we see the same manner of crime reproduced in straight family lines, and yet we dare not look the plain truth full in the face; under the mask of a specious system of correction we hide our fear of facts and our incapacity to act for the criminal individual as well as the noncriminal public.

It is time for us to see that punishment will not abolish crime, any more than a whipping will change a lunatic into a sane man. Until the citizens of a community are really healthy in mind, body, and soul, crime will and must continue in its concomitant ratio. For crime is merely the expression of the action of ordinary social conditions upon distorted and diseased organisms. The symptoms of this pathological state when occurring singly may, as in the common sicknesses, mean but little. But when they come together in recognized groups they point to definite degrees of degeneration. For this reason anthropologists have been trying to classify criminals, to put in their proper places symptoms of weakened will and industry, overweening egoism, a failing respect for consequences, deficient domesticity, insensibility to the higher impulses, as well as the merely physical traits of facial and cranial asymmetry, misshapen heads, epilepsy, idiocy, and the tendency to disfigurement, as in tattooing. It is on the permanency of such traits that Bertillon's system of measurement is founded, as well as Galton's theory of finger markings. The main idea which these facts should impress upon us is the absolute stability of these peculiarities and the inevitable surety of the results which flow from them. The criminal is not necessarily without good impulses; on the contrary, he may have them more or less constantly, but he is unable to act them out. Where the will is thinned out almost to the vanishing point, or where the faculty of concentration has been progressively weakened, it is practically impossible to make up for them, and the unhappy offender is quite at the mercy of circumstances which bring him time and again before the criminal courts. In this connection it is inter-

esting to read from Sir John Strachey's quotation of an official report from India: "When a man tells you that he is a Bodhak, or a Kanjar, or a Sonoria, he tells you what few Europeans ever thoroughly realize—that he, an offender against the law, has been so from the beginning and will be so to the end; that reform is impossible, for it is his trade, his caste—I may almost say his religion—to commit crime."

The belief in the inevitable steadfastness of these personal and family traits will finally clear our moral atmosphere, for we shall and must see that the safety of society lies in right methods of development based upon normal marriages and normal breeding. As population increases and the complexities of life increase, the burdens put upon us become heavier in proportion. We need more mental and moral backbone than we have; we are becoming progressively unable to stand the strain, it has become absolutely necessary to raise men to a higher level. For our present standard in character even more than in brains is a pitiably low one. Just as it is practicable to improve a breed of animals, so is it possible to increase our own worth. It is in this belief that Francis Galton said: "I argue that, as a new race can be obtained in animals and plants, and can be raised to so great a degree of purity that it will maintain itself, with moderate care in preventing the more faulty members from breeding, so a race of gifted men might be obtained, under exactly similar circumstances."

Here we have the gist of the matter. There is a consensus of opinion in the competent that crime is not fortuitous; likewise that there is one sure method for betterment: "*in preventing the more faulty members from breeding.*"

Scientists have known this for a long time; but the mere fact that the opinion was a scientific one kept it from the active appreciation of the many people who go to make up the intelligent class. Now it is time for us to understand the full bearing of the matter, as we certainly must do if we follow to their logical conclusion the teachings of great minds like Darwin and Wallace, like Wilson, Prof. Oscar Schmidt, Dr. Maudsley, and Jonathan Hutchinson; if we would rightly follow the meaning of the brilliant Weismann when he says that heredity is "that property of an organism by which its peculiar nature is transmitted to its descendants. And not only are the characteristics of the species transmitted to the following generation, but even the individual peculiarities." Besides all this, we have the evidence of men of authority, specialists in criminal anthropology, whose conclusions point in exactly the same direction, men like Cesare Lombroso, Ottolenghi, Rossi, Zucarelli, Virgilio Morselli, Marro; to these let us add the names of the eminent Lacassagne, of Kocher, Raux, Bournet. And even then we shall have only a part. The teach-

ing of science all over the world echoes again and again the words of Galton, that the way to better a race lies "in preventing the more faulty members from breeding."

The proper method has been used often enough, but crudely, by such rulers as Ezzelin da Romano, Henry I, and many others.

We need this reform more than any other that has been proposed in our present time. We should look forward to it as we do to the noblest and best aspirations which crown our lives with light, yea, as we look with uplifted eyes for the hope of our best salvation in this world. The earth is reeking with the sweat of evil, injustice, and moral sickness; the means for relief are easily within our reach; they will bring injustice to no one, they will put a stop to millions of wrongs, they will guarantee to our posterity the possibility of a higher career in every way, without the burdensome disadvantages which crowd us to low planes of life. There is no room with us for the confirmed criminal; there is less room for his offspring, for they pollute the place whereon they stand.

THE YOUNG DRAUGHTSMAN.*

By JAMES SULLY, M. A., LL. D.,
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A CHILD'S first attempts at drawing are pre-artistic and a kind of play, an outcome of the instinctive love of finding and producing semblances of things. Sitting at the table and covering a sheet of paper with line-scribble, he is wholly self-centered, "amusing himself," as we say, and caring nothing about the production of "objective values."

Yet even in the early stages of infantile drawing the social element of art is suggested in the impulse of the small draughtsman to make his lines indicative of something to others' eyes, as when he bids his mother look at the "man," "gee-gee," or what else he fancies that he has delineated.† And this, though crude enough and apt to shock the æsthetic sense of the matured artist by its unsightliness, is closely related to art, forming, indeed, in a manner a preliminary stage of pictorial design.

We shall therefore study children's drawings as a kind of rude

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* From advance sheets of Studies of Childhood, by James Sully, M. A., LL. D., in press of D. Appleton & Co.

† This indicative or communicative function of drawing has, we know, played a great part in the early stages of human history. Modern savages employ drawings in sand as a means of imparting information to others—e. g., of the presence of fish in a lake. See den Steinen, Unter den Naturvölkern Braziliens, Kap. x, S. 243 f.

embryonic art. In doing this our special aim will be to describe and explain childish characteristics. This, again, will compel us to go to some extent into the early forms of observation and imagination. It will be found, I think, that the first crude drawings are valuable as throwing light on the workings of children's minds Perhaps, indeed, it may turn out that these spontaneous efforts of the childish hand to figure objects are for the psychologist a medium of expression of the whole of child-nature hardly less instructive than that of early speech.

In carrying out our investigation of children's drawings we shall need to make a somewhat full reference to the related phenomena, the drawings of modern savages and those of early art. While important points of difference will disclose themselves, the resemblances are important enough to make a comparison not only profitable but almost indispensable.

I have thought it best to narrow the range of the inquiry by keeping to delineations of the human figure and of animals, especially the horse. These are the favorite topics of the child's pencil, and examples of them are easily obtainable.

As far as possible I have sought spontaneous drawings of quite young children—viz., from between two and three to about six.* In a strict sense, of course, no child's drawing is absolutely spontaneous and independent of external stimulus and guidance. The first attempts to manage the pencil are commonly aided by the mother, who, moreover, is wont to present a model drawing, and, what is even more important at this early stage, to supply model movements of the arm and hand. In most cases, too, there is some slight amount of critical inspection, as when she asks, "Where is papa's nose?" "Where is doggie's tail?" Yet perfect spontaniety, even if obtainable, is not necessary here. The drawings of men and quadrupeds of a child of five and later disclose plainly enough the childish fashion, even though there has been some slight amount of elementary instruction. Hence I have not hesitated to make use of drawings sent me by kindergarten teachers. I may add that I have used by preference the drawings executed by children in elementary schools, as these appear to illustrate the childish manner with less of parental interference than is wont to be present in a cultured home.

A child's drawing begins with a free, aimless swing of the pencil to and fro, which movements produce a chaos of slightly curved lines. These movements are purely spontaneous, or, if imitative, are so only in the sense that they follow at a consider-

* Only a few drawings of older children above seven have been included.

able distance the movements of the mother's pencil.* They may be made expressive or significant in two ways. In the first place, a child may by varying the swinging movements accidentally produce an effect which suggests an idea through a remote resemblance. A little boy, when two years and two months, was one day playing in this wise with the pencil, and happening to make a sort of curling line, shouted with excited glee, "Puff, puff!"—i. e., smoke. He then drew more curls with a rudimentary intention to show what he meant. In like manner, when a child happens to bend his line into something like a closed circle or ellipse, he will catch the faint resemblance to the rounded human head and exclaim, "Mamma!" or "Dada!"

But intentional drawing or designing does not always arise in this way. A child may set himself to draw, and make believe that he is drawing something when he is scribbling. This is largely an imitative play-action following the directions of the movements of another's hand. Preyer speaks of a little boy who in his second year was asked when scribbling with a pencil what he was doing and answered, "Writing houses." He was apparently making believe that his jumble of lines represented houses.†

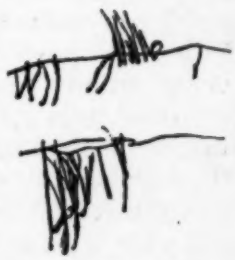

FIG. 1.

The same play of imagination is noticeable in the child's first endeavors to draw an object from memory when he is asked to do so. Thus a little girl in her fourth year, referred to by Mr. E. Cooke, when asked to draw a cat, produced a longish, irregularly curved line crossed by a number of shorter lines, which strange production she proceeded quite complacently to dignify by the name of "cat," naming the whiskers, legs, and tail (Fig. 1, *a*); compare the slightly fuller design in Fig. 1, *b*.

Here it is evident we have a phase of childish drawing which is closely analogous to the symbolism of language. The representation is arbitrarily chosen as a symbol and not as a likeness. This element of a nonimitative or symbolic mode of representation will be found to run through the whole of childish drawing.

Even this chaotic scribble shows almost from the beginning germs of formative elements, not merely in the fundamental line elements, but also in the loops, and in the more abrupt changes of direction or angles. A tendency to draw a looplike rudimen-

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* E. Cooke gives illustrations of these in his thoughtful and interesting articles on Art-teaching and Child-nature, published in the Journal of Education, December, 1885, and January, 1886.

† Preyer, *op. cit.*, p. 47.

tary contour soon emerges, and thus we get the transition to a possible outlining of objects. With practice the child acquires by the second or third year the usual stock in trade of the juvenile draughtsman, and can draw a sort of straight line, curved lines, a roughish kind of circle or oval, as well as dots, and even fit lines together at angles.* When this stage is reached we begin to see attempts at real though rude likenesses of men, horses, and so forth. These early essays are among the most curious products of the child-mind. They follow standards and methods of their own; they are apt to get hardened into a fixed conventional manner which may reappear even in mature years. They exhibit with a certain range of individual difference a curious uniformity, and they have their parallels in what we know of the first crude designs of the untutored savage.

It has been wittily observed by an Italian writer on children's art that they reverse the order of natural creation in beginning instead of ending with man. It may be added that they start with the most dignified part of this crown of creation, viz., the human head. A child's first attempt to represent a man proceeds, so far as I have observed, by drawing the front view of his head. This he effects by means of a clumsy sort of circle with a dot or two thrown in by way of indicating features in general. A couple of lines may be inserted as a kind of support, which do duty for both trunk and legs. The circular or ovoid form is, I think, by far the most common. The square head in my collection appears only very occasionally and in children *at school*, who presumably have had some training in drawing horizontal and vertical lines. The accompanying example (Fig. 2) is the work of a Jamaica girl of five, kindly sent me by her teacher.

FIG. 2.

This first attempt to outline the human form is, no doubt, characterized by a high degree of arbitrary symbolism. The use of a rude form of circle to set forth the human head reminds one of the employment by living savage tribes of the same form as the symbol of a house (hut?), a wreath, and so forth. Yet there is a measure of resemblance

* I am much indebted to Mr. Cooke for the sight of a series of early scribbles of his little girl. *Cf.* Baldwin, Mental Development, chapter v, where some good examples of early line-tracing are given. According to Baldwin, angles or zigzag come early, and are probably due to the cramped, jerky mode of movement at this early stage. Preyer seems to me wrong in saying that children can not manage a circular line before the end of the third year (*op. cit.*, p. 47). Most children who draw at all manage a loop or closed curved line before this date.

even in this abstract symbolism: the circle does roughly resemble the contour of the head: as, indeed, the square or rectangle may be said less obviously to do when hair and whiskers and the horizontal line of the hat break the curved line.

Fig. 3.

But it is not the mere contour which represents the face: it is a circle picked out with features. These, however vaguely indicated, are an integral part of the facial scheme. This is illustrated in the fact that among the drawings by savages and others collected by General Pitt-Rivers, one, executed by an adult negro of Uganda, actually omits the contour, the human head being represented merely by an arrangement of dark patches and circles for eyes, ears, etc. (Fig. 3).*

Coming now to the mode of representing the features, we find at an early stage of this schematic delineation an attempt to differentiate and individualize features, not only by giving definite position but by a rough imitation of form. Thus we get the vertical line as indicating the direction of the nose, the horizontal line that of the mouth, and either a rounded dot or a circular line as representative of the curved outline of the eye—whether that of the iris, of the visible part of the eyeball, or of the orbital cavity. A precisely similar scheme appears in the drawings of savages.†

At first the child is grandly indifferent to completeness in the enumeration of features. Even "the two eyes, a nose, and a mouth" are often imperfectly represented. Thus, when dots are used, we may have one or more specks, ranging, according to M. Perez, up to five.‡ The use of a single dot for facial feature in general has its parallel in the art of savage tribes.* It is, however, I think. most common to introduce three dots in a triangular arrangement, presumably for eyes and mouth—a device, again, which reappears in the art of uncivilized races.‖ Even when the young draughtsman has reached the stage of distinguishing the features he may be quite careless about number and completeness. Thus a feature may be omitted altogether. This funnily enough happens most frequently in the case of that

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* These drawings, of the highest interest to the student of child-art as well as to the anthropologist, are to be seen in the general's museum at Farnham (Dorset) (seventh room).

† Schoolcraft has a good example of this facial scheme in the drawing of a man shooting (The Indian Tribes of the United States, vol. i, plate 48).

‡ L'Art et la Poésie chez l'Enfant, p. 186.

* For an illustration see Andree, Eth. Parallelen und Vergleiche, plate 3, Fig. 19.

‖ See, for an example, Schoolcraft, vol. iv, plate 28.

one which seems to us "grown-ups" most self-assertive and most resentful of indignity, viz., the nose. These moon-faces with two eyes and a mouth are very common among the first drawings of children. The mouth, on the other hand, is much less frequently omitted. The same thing seems to hold good of the drawings of savages.* The eyes are rarely omitted. The single dot may perhaps be said to stand for "eye." Some drawings of savages have the two eyes and no other feature, as in the accompanying example from Andree (Fig. 4, *a*). On the other hand, a child

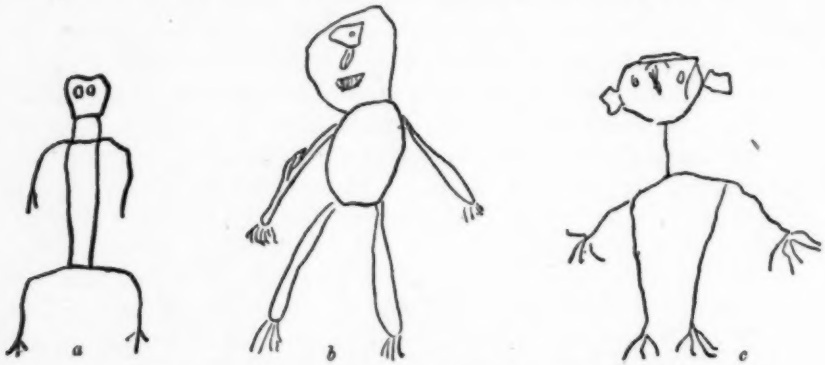

FIG. 4.—*c*, Mustache = horizontal line above curve of cap.

will, as we have seen, sometimes content himself with one eye. This holds good not only where the dot is used but after something like an eye-circle is introduced, as in the accompanying drawing by a Jamaica girl of seven (Fig. 4, *b*).

In these first attempts to sketch out a face we miss a sense of relative position and of proportion. It is astonishing what a child on first attempting to draw a human or animal form can do in the way of dislocation or putting things into the wrong place. The little girl mentioned by E. Cooke on trying, about the same age, to draw a cat from a model; actually put the circle representing the eye outside that of the head. With this may be compared the drawings of den Steinen and other Europeans made by his Brazil Indian companions, in which what was distinctly said by the draughtsman to be the mustache was in more than one instance set above the eyes (Fig. 4, *c*). When dots are inserted in the linear scheme they are apt at first to be thrown in anyhow. The two eyes, I find, when these only are

* According to Stanley Hall, the nose comes after the mouth. This may be an approximate generalization, but there are evidently exceptions to it. On the practice of savage draughtsmen see the illustrations of Australian cave drawings in Andree, *op. cit.*, p. 159. *Cf.* the drawings of Brazilian tribes, plate iii, 15. In some cases there seems a preference for the nose, certain of the Brazilian drawings representing facial features merely by a vertical stroke.

given, may be put one above the other as well as one by the side of the other, and both arrangements occur in the drawings of the same child. And much later, when greater attention to position is observable, there is a general tendency to put the group of features too high up—i. e., to make the forehead or brain region too small in proportion to the chin region (see Fig. 2).*

The want of proportion is still more plainly seen in the treatment of the several features. The eye, as already remarked, is apt to be absurdly large. In the drawing of Mr. Cooke's little girl, mentioned above, it is actually larger than the head outside which it lies. This enlargement continues to appear frequently in later drawings, more particularly when one eye only is introduced, as in the accompanying drawing by a boy in his seventh year (Fig. 5 *a*, and Fig. 4, *b*). The mouth is apt to be even more disproportionate, the child appearing to delight in making this appalling feature supreme, as in the following examples, both by

FIG. 5.

boys of five (Fig. 5, *b* and *c*). The ear, when it is added, is apt to be enormous, and generally the introduction of new details, as ears, hair, hands, is wont to be emphasized by an exaggeration of their magnitude.

Very interesting is the gradual artistic evolution of the features. Here, as in organic evolution, there is a process of specialization, the primordial indefinite form taking on more of characteristic complexity. In the case of the eye, for example, we may often trace a gradual development, the dot being displaced by a small circle or ovoid, this last supplemented by a second circle outside the first,† or by one or by two arches, the former placed above, the latter above and below the circle.

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* M. Passy calls attention to this in his interesting note on children's drawings, Revue Philosophique, 1891, pp. 614 ff. I find, however, that though the error is a common one, it is not constant.

† In one case I find the curious device of two dots or small circles, one above the other within a larger circle, and this form repeated in the eye of animals.

The evolution of the mouth is particularly interesting. It is wont to begin with a horizontal line (or what seems intended for such) which is frequently drawn right across the facial circle. But a transition soon takes place to a more distinctive representation. This is naturally enough carried out by the introduction of the characteristic and interesting detail, the teeth. This may be done, according to M. Perez, by keeping to the linear representation, the teeth being indicated by dots placed upon the horizontal line. In all the cases observed by me the teeth are introduced in a more realistic fashion in connection with a contour to suggest the parted lips. The contour—especially the circular or ovoid—occasionally appears by itself without teeth, but the teeth seem to be soon added. The commonest forms of tooth cavity I have met with are a narrow rectangular and a curved spindle-shaped slit with teeth appearing as vertical lines (see the two drawings by

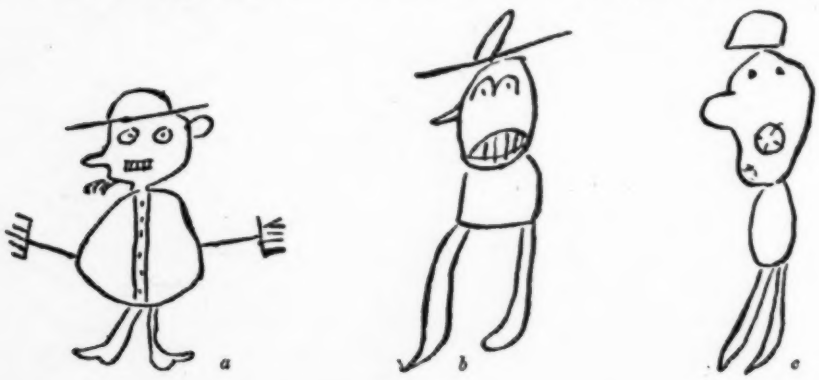

FIG. 6.

boys of six and five (Figs. 6, *a* and *b*). These two forms are improved upon and more likeness is introduced by making the dental lines shorter, as in Fig. 5, *c*. With this may be compared a drawing by a boy of five (Fig. 6, *c*), where, however, we see a movement from realism in the direction of a freer decorative treatment.

A somewhat similar process of evolution is noticeable in the case of the nose, though here the movement is soon brought to a standstill. Thus the vertical line gives place to an angle, which may point to the side, as in the drawing of a country boy between three and four (Fig. 7, *a*), but more frequently, I think, points upward, as in the drawing of a boy of six (Fig. 7, *b*). This in its turn leads to an isosceles triangle with an acute angle at the apex, as in the drawing of a boy of six (Fig. 7, *c*). In a few cases a long spindle-shaped or rectangular form similar to that of the mouth is employed, as in a drawing of a nervous child of six (Fig. 7, *d*). Refinements are introduced now and again by an attempt at the

nostrils, as in the accompanying curious drawing by a seven-year-old Jamaica girl (Fig. 7, *e*).*

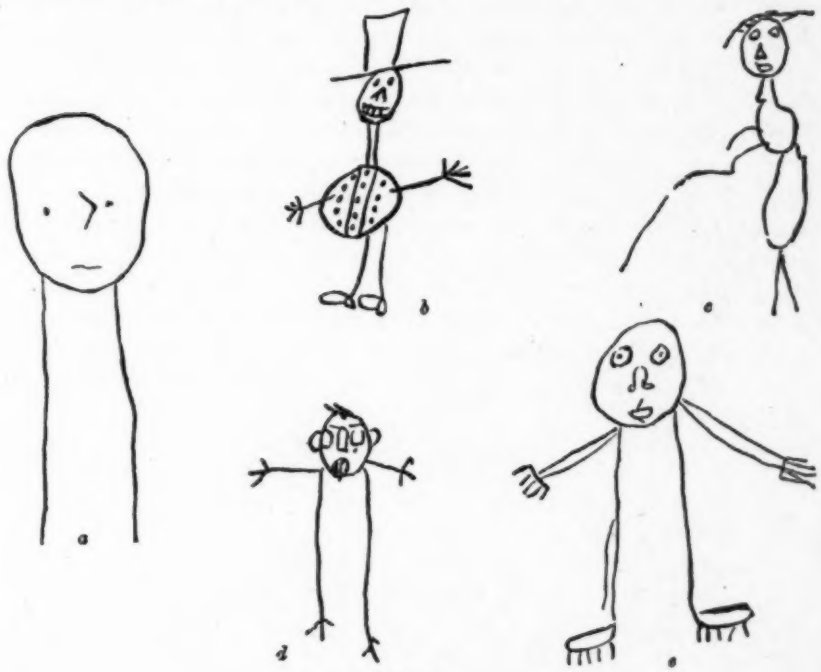

FIG. 7.

The introduction of other features, more especially ears and hair, must, according to my observations, be looked on as occasional only, and as a mark of an advance to a more naturalistic treatment. Differences of treatment occur here too. Thus the ears, which are apt to be absurdly large, are now inserted inside the head circle, now outside it. The hair appears now as a dark cap of horizontal strokes, now as a kind of stunted fringe, now as a bundle or wisp on one side, which may either fall or stand on end (see Fig. 7, *d*, and the accompanying drawing by a girl of nearly four, Fig. 8, *a*). These methods of representation are occasionally varied by a more elaborate line device, as a curly looped line similar to

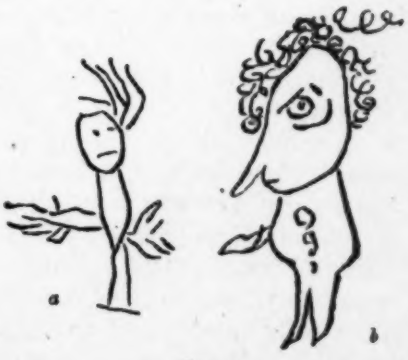

FIG. 8.

* It is possible that in this drawing the two short lines added to the mouth are an original attempt to give the teeth.

that employed for smoke, as in the annexed drawing by a girl of seven (Fig. 8, *b*).

As implied in this account of the facial features, a good deal of conventionlike agreement of method is enlivened by a measure of diversity of treatment. Perhaps one of the most striking instances of daring originality is seen in the attempt by a girl of four—who was subjected to a great deal of instruction—to give separate form to the chin (Fig. 9). This may be compared with the attempt of the Uganda negro to indicate symbolically the cheeks (see Fig. 3).

FIG. 9.

FIG. 10.

As I have remarked, to the child bent on representing "man" the head or face is at first the principal thing, some early drawings contenting themselves with this. But in general the head receives some support. The simplest device here is the abstract mode of representation by two supporting lines, which do duty for legs and body. These are for the most part parallel (Fig. 2), though occasionally they are united at the top, making a kind of target figure. This same arrangement, fixing the head on two upright lines, meets us also in the rude designs of savages, as may be seen in the accompanying rock inscription from Schoolcraft (Fig. 10).

The comparative indifference of the child to the body or trunk is seen in the obstinate persistence of this simple scheme of head and legs, to which two arms attached to the sides of the head are often added. A child will complete the drawing of the head by

FIG. 11.

FIG. 12.

inserting hair or a cap, and will even add feet and hands, before he troubles to bring in the trunk (see Fig. 2 and Fig. 7, *d*, also the accompanying drawing by a boy of six, Fig. 11, *a*). With this neglect of the trunk by children may be compared the omission

of it—as if it were a forbidden thing—in one of General Pitt-Rivers's drawings, executed by a Zulu woman (Fig. 11, *b*).

From this common way of spiking the head on two forked or upright legs there is one important deviation. The contour of the head may be left incomplete, and the upper occipital part of the curve be run on into the leg lines, as in the accompanying example by a Jamaica girl of seven (Fig. 12). I have met with no example of this among English children.

The drawing of the trunk may commence in one of two ways. With English children it appears often to emerge as an expansion or prolongation of the head contour, as in the accompanying drawings of the front and side view (Figs. 13, *a* and *b*).* Or, in the second place, the leg scheme may be modified, either by draw-

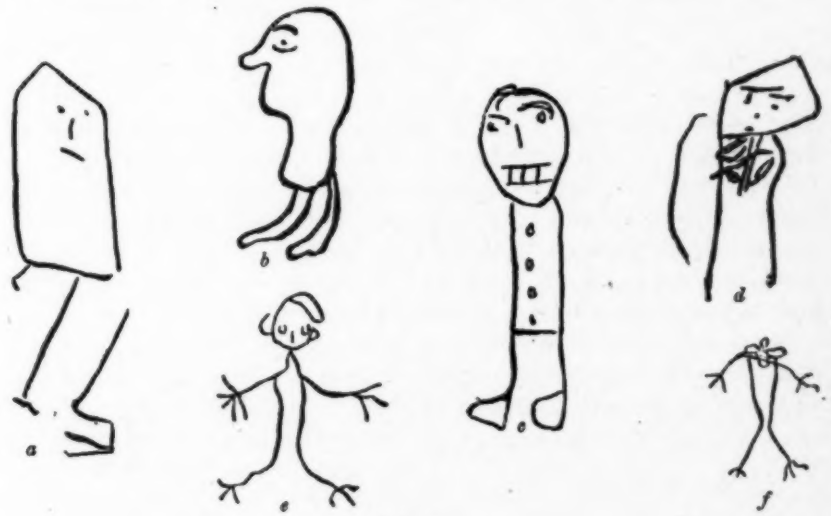

FIG. 13.

ing a horizontal line across them and so making a rectangle, as in the accompanying drawing by a boy of six, or by shading in the upper part of the space, as in the other figure by a girl of five (Fig. 13, *c* and *d*). A curious and interesting variant of this second mode of introducing the trunk is to be found in the drawings of den Steinen's Brazilians, where the leg lines are either kept parallel for a while and then made to diverge, or are pinched in below what may be called the pelvis, though not completely joined (Fig. 13, *e* and *f*).

When the trunk is distinctly marked off, it is apt to remain small in proportion to the head, as in the following two drawings

* A drawing given by Andree, *op. cit.*, plate ii, 11, seems to me to illustrate a somewhat similar attempt to develop the trunk out of the head.

by boys of about five (Fig. 14, *a* and *b*). As to its shape, it is most commonly circular or ovoid like the head. But the square or rectangular form is also found, and in the case of certain chil-

FIG. 14.

dren it is expressly stated that this came later. A triangular capelike form also appears now and again, as in the accompanying drawing by a boy of six (Fig. 14, *c*).* The treatment of the form of trunk often varies in the drawings of the same child.

At this stage there is no attempt to show the joining on of the head to the trunk by means of the neck. The oval of the head is either laid on the top of that of the trunk, or more commonly cuts off the upper end of the latter. The neck, when first added, is apt to take the exaggerated look of caricature. It may be represented by a single line, by a couple of parallel lines, or by a small oval or circle, as in the accompanying drawings by a girl of six and a boy of five respectively (Fig. 15, *a* and *b*; also Fig. 7, *b*).

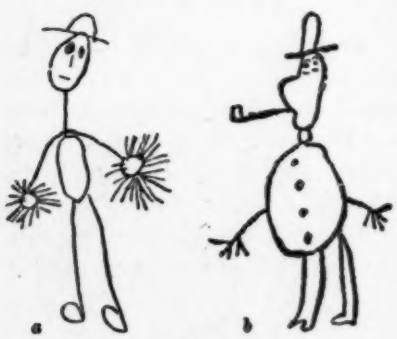

FIG. 15.

It is noticeable that there is sometimes a double body, two oval contours being laid one upon the other. In certain cases this looks very like an expansion of the neck, as in the following drawing by the same boy that drew the round neck above (Fig. 16, *a*). In other cases the arrangement plainly does not aim at differentiating the neck, since this part is separately dealt with (Fig. 16, *b*). Here it may possibly mean a crude attempt to indicate the division of the trunk at the waist, as brought out espe-

* The opposite arrangement of a triangle on its apex occurs among savage drawings.

cially by female attire, as may be seen in the accompanying drawing, where the dots for buttons on each oval seem to show that the body is signified (Fig. 16, *c*; *cf.* Fig. 7, *c*).* This, along with the triangular cape-shape of the trunk, is one of the few illustrations of the effect of dress on the first childish treatment of the figure. As a rule, this primitive art is a study of Nature in so far as the artificial adjuncts of dress are ignored, and the rounded forms of the body are, though crudely enough, no doubt, hinted at.

Coming now to the arms, we find that their introduction is very uncertain. To the child, as also to the savage, the arms are what the Germans call a *Nebensache*—side matter (i. e., figuratively as well as literally)—and are omitted in rather more than

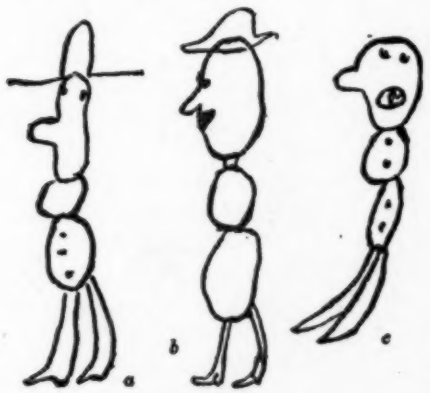

Fig. 16.

Fig. 17.

one case out of two. After all, the divine portion, the head, can be supported very well without their help.

The arms, as well as the legs, being the thin, lanky members, are commonly represented by lines. The same thing is noticeable in the drawings of savages.† The arms appear in the front view of the figure as stretched out horizontally, or at least reaching out from the sides; and their appearance always gives a certain liveliness to the figure, an air of joyous self-proclamation, as if they said in their gesture language, "Here I am!" (see Fig. 5, *a*, and the accompanying drawing of a boy of six, Fig. 17).

In respect of shape and structure a process of evolution may be observed. In certain cases the abstract linear representation gives place to contour, the arm being drawn of a certain thickness. But I find that the linear represenation of the arm often

* On the other hand, I find the button dots sometimes omitted in the lower oval.

† For examples, see Andree, *op. cit.*, plate 3. *Cf.* the drawings of den Steinen's Braziliana.

persists after the legs have received contour, this being probably another illustration of the comparative neglect of the arm; as in the accompanying drawing by a boy of five (Fig. 18, *a*). The primal rigid straightness yields later on to the freedom of an

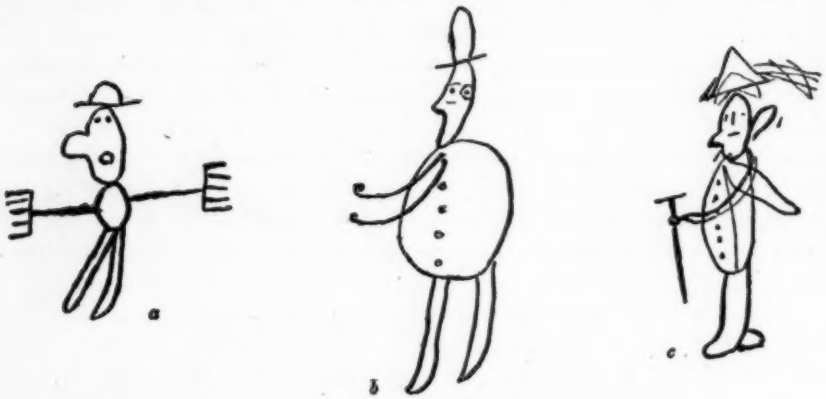

FIG. 18.—*c*, A miner.

organ. Thus an attempt is made to represent by means of a curve the look of the bent arm, as in the accompanying drawings by boys of five (Fig. 18, *b* and *c*). In other cases the angle of the elbow is indicated. This last comes comparatively late in children's drawings, which here, too, lag behind the crudest outline sketches of savages.

SKETCH OF ANDREW DICKSON WHITE.

BY PROF. GEORGE L. BURR.

ALMOST in the exact geographical center of the State of New York there suns itself in the upper valley of a tributary of the Susquehanna a tidy village on which the impoverished fancy of an official map-maker has set the ancient name of Homer. Ancient, indeed, for its region is the village itself. The settlers from Massachusetts and from Connecticut who pushed westward along the valleys of the Mohawk and the Susquehanna, reaching these uplands in the last decade of the eighteenth century, settled here more thickly than elsewhere, and for half a century—till its neighbor settlement of Cortland, once its suburb but soon its rival, crowded it from the pre-eminence—it was, not only in the number of its citizens, but in their thrift, their piety, and their public spirit, the recognized metropolis of the district.

It was here, in the midst of all that is conservative in American life, that on the 7th of November, 1832, was born a man destined in much to be a leader of the fresher thought—ANDREW

DICKSON WHITE. His grandfather, Asa White, a migrant from southern Massachusetts in 1798, was long the well-to-do miller of the little community, but in 1815 a conflagration brought him in a day to poverty; and his eldest son Horace, the father of Andrew, was forced, though but a lad of thirteen, to turn from the education of the schools to that of business. So well he learned its lessons that before the age of thirty he had not only won a reputation for unusual mercantile sagacity and enterprise, but had already amassed a moderate fortune when in 1831 he married Clara Dickson, only daughter of a village magnate. Her father, the Hon. Andrew Dickson, like the Whites of Massachusetts birth, had come a young man to Homer and was, in the year of his grandson's advent, the representative of his county in the Legislature of the State.

The fortunes of Horace White still prospered, and in 1839 he took advantage of the new banking law of the State to establish himself as one of the earliest bankers at Syracuse, the rising metropolis of central New York, then a town of some five thousand people. There his energy found a worthier field; identified with all the interests of his city, he rapidly amassed wealth, and all the advantages his own youth had missed he could well afford his son.

The earliest tastes of the boy were, however, not bookish; all his love was for machinery and for the wonders of out of doors; and, though he early picked up the power to read, it was not until after the removal to Syracuse that he was first put into school. Of his education he has himself told the story:

"After much time lost in various poor schools, I was sent to the preparatory department of the Syracuse Academy, and there, by good luck, found Joseph A. Allen, the best teacher of English branches I have ever known. . . . He seemed to divine the character and enter into the purpose of every boy." There young White perfected himself in spelling, in arithmetic, in geometry, the only mathematical study he ever loved, in grammar, of which he thinks there was too much; there he gained the rudiments of natural science and even of music, becoming "proficient enough to play the organ occasionally in church." There, too, literature was first opened to him. "Great attention was given to reading aloud from a book made up of selections from the best authors, and to recitals from these. Thus I stored up not only some of the best things in the older English writers, but inspiring poems of Whittier, Longfellow, and other moderns," and the treasures thus gained were never lost. "As to the moral side, Mr. Allen influenced many of us strongly by liberalizing and broadening our horizon. He was a disciple at that time of Channing, and an abolitionist; but he . . . never made the slightest attempt to

proselyte any of his students. Yet the very atmosphere of the school made sectarian bigotry and narrowness impossible."

But the boy was destined for college, and was now sent to a classical school, where Stoddard, the story writer, was among his fellow-pupils, and where, though the methods in classical teaching were imperfect, "the want in grammatical drill was more than made up by the love of manliness and the dislike of meanness which was in those days our very atmosphere."

Outside the school his imagination had been stimulated by desultory reading and by pictures of travel, and he had stumbled upon the novels of Scott, to which above all was due the birth of his interest in historical studies. The public meetings of the time, especially those of the antislavery party, took also a deep hold upon his mind.

He had dreamed of entering one of the great New England universities; but the zealous young churchman into whose hands he was put for his final training persuaded his father to send him instead to the young and struggling Episcopal college at the neighboring town of Geneva. There he matriculated in the fall of 1849. With all his loyalty to his father's church and to his father's wish, the college could not content him. Dependent on the wealthy patrons whose sons it sought to educate, its discipline was lax and its means too feeble for the work it undertook. "Only about half a dozen of our number studied at all; the rest, by translations, promptings, and evasions of various sorts, escaped without labor."

A year of this was all that he could stand, and when, at the opening of another, his protest was still unheeded, he took French leave of his reluctant *alma mater* and went into hiding at the home of an old instructor until his father at last gave consent to his transfer to Yale College. There he was admitted in January, 1851, to what has since become "the famous class of '53." But, even among such classmates as Billings and Davies and Gibson and Lewis and MacVeagh and Robinson and Shiras and Smalley and Stedman, he soon won for himself a high place—not so much by his work in the classroom, though that was good, as by the breadth of his information and of his sympathies, and by his facility with pen and voice. He became an editor of the college magazine, The Lit., and before his graduation won the first Clark, the Yale Literary, and the De Forest prizes, the last for an essay on The History of Modern Diplomacy. Nor were physical and social claims neglected. He belonged to the earliest Yale crew, and he became a member of Psi Upsilon and of the mystic Skull and Bones, as well as of the more literary Linonia. His roommate and bosom friend was his classmate Davies, to-day Bishop of Michigan. Of his college work, perhaps that which left the

deepest impression upon him was his study of Guizot's Civilization in Europe, under Dr. Woolsey.

In December, 1853, he went abroad for further study, having as fellow-traveler his college mate (now the well-known President of Johns Hopkins, and at this moment his colleague on the Venezuelan Commission). After a few weeks in England and several months in France, spent in studying French, reading the French historians (Thierry, Mignet, Thiers, Chateaubriand), listening to lecturers like Laboulaye at the Sorbonne and the College of France, chatting with the old soldiers of the Revolution at the Invalides, making historical pilgrimages throughout the northern and central provinces, everywhere reveling in architecture and music and haunting the old book shops, he was invited by the American minister to Russia, ex-Governor Seymour, of Connecticut, to join that legation as an *attaché*.

Accordingly, in October of 1854 he made his way, *via* Brussels, Cologne, and Berlin, to St. Petersburg. It was the stirring time of the Crimean War, and the young diplomat found his attachéship no sinecure. His knowledge of French made him valuable as an interpreter; he became the companion of the minister in his interviews at court and at the foreign office, and took a most interested part in the ceremonial attending the death of the Czar Nicholas and the accession of Alexander II. Yet he found much time for study. Huge scrap-books were filled with clippings on the progress of the war; the book-stalls afforded rich store for his rapidly growing collection on Russia and Poland; and the archives of the legation even gave him material for research in American history. He there, under the inspiration of Mr. Seymour, became interested in the character and policy of Jefferson, and drew up the nucleus of the study later published in the Atlantic Monthly on Jefferson and Slavery.

But he tired of the restraints of official life, and in June, 1855, resumed the career of a student, first wandering in Germany and Switzerland, then matriculating at the University of Berlin. There he heard Boeckh, Lepsius, Friedrich von Raumer, Karl Ritter, and tried in vain to follow the lectures of Ranke. With the Easter vacation he was off for Austria and Italy, and lingered till late spring beyond the Alps, in the company of his fellow-student and close friend Frieze, the Latinist. Crossing then the Alps, and lingering but a little among the Roman ruins of southern France, he turned his footsteps homeward, reaching America in time to share the commencement festivities of his *alma mater* and to receive at her hands his Mastership of Arts.

It was then, with his future profession all undecided, that he chanced to stray within sound of the voice of President Francis Wayland, who was delivering at Yale one of the addresses of the

commencement season; and the orator's plea for the new and growing West as the field for the young scholar sank deep into his mind. The next year he spent in graduate study at Yale, and before its end, declining all other offers, he had accepted the chair of History and English Literature at the University of Michigan.

He was but five and twenty, and looked a boy, but the vigor of his thought and the finish of his style soon dispelled all doubt as to his maturity. "He came to Ann Arbor," says one who then listened to him, "fresh from European studies, and he entered upon his labor with that peculiar enthusiasm which is instantly caught by students, and is perhaps the most successful element of all good teaching. His instruction in history was a genuine revelation to those who had been accustomed to perfunctory text-book work and the hearing of dry and colorless lectures. The exceptional excellence of his instruction consisted largely of the spirit which he infused into his students. He had in a remarkable degree the rare gift of seizing upon the most important principles and causes and presenting them in such a manner as to illuminate the whole course of events with which they were connected. He not only instructed, but, what was even more important, he inspired. While he remained in his chair perhaps no study in the university was pursued with so much enthusiasm by the mass of students as was that of history."

In the general development of the university he was like his old friend Frieze, whom, to his joy, he found a fellow-member of the Michigan faculty, a loyal supporter and adviser of President Tappan. And there was work to do outside the institution. The university, in order to keep its hold on the State, from which it drew its support, loved to send out its faculty as lecturers into the towns and villages of Michigan, and into this task, too, the young Professor of History went with zest and success.

On the eve of his going to Michigan he had married, at Syracuse, Mary Outwater, a neighbor's daughter, whom he had known and admired since her childhood. He was fond of entertaining his colleagues and students; and Mrs. White united in her character a sweetness and a dignity which made her the most charming of hostesses. Their home soon became at Ann Arbor, as afterward at Cornell, the very heart of the university's social life. There, in his growing library, amid the influences of art and music so dear to him, Prof. White ministered a hospitality which could have meant hardly less to the culture of those who shared it than did the work of his classroom.

The death of his father, in 1860, brought upon him the cares of fortune; his health, never strong, flagged under the accumulated burden. In 1862 he found it wise to ask a leave of absence, and sailed with his family, now numbering a daughter and a son

besides his wife, for Europe. The civil war then raging in America had stirred him deeply, and his had been no slight share in sending to the field the young manhood of the North. Now, arrived in Europe, a new task confronted him. In answer to the pro-Southern correspondents of the London press, who were misleading the English public as to the resources and the character of the North, and bade fair to win for the Confederacy the recognition, if not the intervention, of Great Britain, he dashed off his A Word from the Northwest, perhaps the most telling defense of the Unionist cause; and this he followed up with effective letters in the journals of England and the Continent. Returning in 1863 to the financial cares which demanded his presence in Syracuse, he found in domestic politics a fresh field for his powers as a writer and orator, and in the autumn of that year was sent by his native county of Onondaga to the Senate of New York.

Of this body, in which he sat till 1867, he was, though its youngest member, from the first a man of influence. Against the peace sympathies of Governor Seymour he was an eloquent and effective advocate of the aggressive prosecution of the war. Though a director of the New York Central Railroad and a resident of the city most dependent on the Erie Canal, he did loyal service as an opponent of the dictation both of railway and of canal ring. His intelligent interest in civic affairs earned him a place on the legislative Committee on Municipal Reform, where he was especially concerned in the organization on its present basis of the Health Department of New York city. But it was as chairman of the educational committee, or Committee on Literature, as it was called, that there opened to him the largest opportunities. He was able to carry through a great extension of the normal school system for the training of teachers. What was more, the beneficence of the national Government seemed to put within reach what had long been the dearest dream of his public life.

Even while a boy at the Geneva College, as he paced rebelliously the shore of Seneca Lake, he had begun to frame in his thought the great university, worthy of the greatest State of the Union, by which New York should some day make needless all petty sectarian institutions. When Gerrit Smith had later talked of endowing a university in central New York, he had offered the half of his own fortune for such an object. The dream ripened during his years at Michigan. "It is now just about ten years ago," said George William Curtis in 1868, "since I was in the city of Ann Arbor, the seat of the University of Michigan, . . . and I sat at night talking with my friend, a New York scholar, Professor of History in that institution. . . . There, in the warmth and confidence of his friendship, he unfolded to me his idea of the

great work that should be done in the great State of New York. Surely, he said, in the greatest State there should be the greatest of universities; in central New York there should arise a university which, by the amplitude of its endowment and by the whole scope of its intended sphere, by the character of the studies in the whole scope of the curriculum, should satisfy the wants of the hour. More than that, said he, it should begin at the beginning. It should take hold of the chief interest of this country, which is agriculture; then it should rise—step by step, grade by grade—until it fulfilled the highest ideal of what a university could be. . . . Until the hour was late this young scholar dreamed aloud to me these dreams."

Now, in the year 1862 an act had passed Congress for the endowment of the higher education throughout the country, from the great landed domain of the nation. Every State was to receive for each of its representatives in Congress thirty thousand acres of the public land with which each should endow "at least one college," where, "without excluding other scientific and classical studies," such branches as are related to agriculture and the mechanic arts should forever be taught. To New York, as the most populous State, came thus nearly a million of acres. This superb fund, provisionally bestowed by the State on a small existing institution, seemed likely in 1864 to fall back into its hands through a failure to comply with the conditions of the gift. Mr. White strenuously opposed all suggestions for the division of the fund, urging as the only worthy policy for the higher education the concentration of resources. It was in the struggle over this question that he was brought into close relations with his colleague from Tompkins County, Ezra Cornell—a stern, shrewd old man, of Quaker birth and breeding, who had migrated in his youth, a roving mechanic, into western New York, where, after making one fortune in milling and losing it in farming, he had built up a vaster one through his connection with the spread of the electric telegraph, and now, in his declining years, was casting about for a worthy public use for his wealth. The two men were strangely unlike, and as to the division of the land grant they had been sharply opposed; but each had learned to prize the other, and it was to his young fellow-Senator that the old Quaker now turned for advice. The result was the offer, by Ezra Cornell to the State of New York, of five hundred thousand dollars for the further endowment of a great university, if the State would transfer to it the public lands and would locate it in his own town of Ithaca.

It is needless here to recount further the tangled story of the establishment of Cornell University, or to describe the happy policy by which the nation's gift, frittered away for a song by

most of the States, became in time for the New York university the source of millions. Large as was Mr. White's share in securing for it the charter and the land grant, what was peculiarly his own was the educational shaping of the new institution. He was its spiritual founder not less than Mr. Cornell its material—a fact too much obscured, perhaps, by the name which he, against Mr. Cornell's protest, gave to the university. It was he who wrote all but the financial clauses of its charter; he who drew its plan of organization; he who took all steps looking to the selection of its equipment and the choice of its faculty. It is not strange that when, in 1866, a head was to be found for it, Mr. Cornell insisted that Mr. White must accept its presidency.

It was to turn his back on political ambitions to which he had earned a right. It was to sever his connections with Michigan, where, in the hope that he might yet return, the chair of History was still his. Just now, too, there had come from Yale an invitation to take up his home in the "City of Elms" as director of its School of Fine Arts; and this, if he must leave his political career, was the life most tempting to a man of his tastes and means, and was especially attractive to his family. But his choice was soon made, and was made once for all. Entering at once upon his executive duties, he remained President of Cornell for nearly twenty years, until ill health compelled his retirement in 1885.

The features in which the new university, as planned by him, differed most notably from others of its sort were: (1) Its democracy of organization, uniting the humanities, the sciences, and the technical arts in a single faculty and in common classrooms under precisely like conditions, and this so effectively that their parity at Cornell has never been questioned; (2) its freedom from all sectarian control—"at no time shall a majority of [its trustees] be of one religious sect, or of no religious sect," and "persons of every religious denomination, or of no religious denomination, shall be equally eligible to all offices and appointments"; (3) its parallel courses and its large individual freedom of choice among studies—in this, too, it was a pioneer in American education; (4) its vital connection with the public schools of its State through the establishment of free scholarships, to be awarded by competition in each Assembly district; (5) its large recognition of the worth of the modern languages and literatures, both as practical and as disciplinary studies; (6) its system of nonresident professorships, by which it sought to bring both its students and its faculty in touch with eminent scholars whose permanent services it could not hope to win; (7) its assumption that its students are not children, but grown and earnest men, and its attitude toward them as such.

Much that was planned at the outset could not, for lack of means, be then or for long afterward carried out. In fact, throughout nearly the whole administration of Mr. White the institution was "land poor"—its vast estates an expense instead of an income.

Throughout his presidency Mr. White filled also the professorship of History, and with the same inspiring influence upon historical studies as at the University of Michigan. Though his other duties compelled his restriction to a single course throughout the year, no element of the university's work left a deeper mark upon the whole student body.

And his benefactions took often a more tangible form. From his own means he built and furnished upon the university's grounds the home which he gave to be used, when he should be through with it, by his successors in the presidency. Of his lesser gifts it would be idle to attempt enumeration. No department but felt again and again the help of his ready pocket. The library especially was continually his debtor, and after his retirement he bestowed upon it in 1887 his own noble historical collection, perhaps the richest private library in America. His gifts must aggregate a couple of hundred thousand dollars. In proportion to his income he has perhaps been the university's most liberal donor.

But during these years of his presidency he was not wholly divorced from outside activities. His fertile mind and restless temperament could not brook such slavery. He was always in touch with the republic of letters and with the larger interests of State and nation. His open letters and occasional addresses amount to volumes. In 1870 he was appointed by President Grant a member of the commission created by Congress for the investigation of the condition and resources of Santo Domingo, and into his hands fell the scientific direction of the expedition. Though its youngest member, he proved the conservative element of the commission, and it was in deference to his protests that no recommendation as to annexation was made by it. In the fall of 1871 he presided at the State convention of his party at Syracuse. The next year saw him a delegate at large to the national convention at Philadelphia which renominated President Grant, and a little later the head of New York's delegation in the electoral college. In 1876 he was again a delegate at large to the Republican National Convention, but was hindered from attendance by other official duties in connection with the Centennial Exhibition at Philadelphia, where he had been made chairman of the Jury of Public Instruction. Soon after this ill health drove him abroad, and before his return in 1878 he served the United States as its Honorary Commissioner to the Paris Exposition, and was

there given a place upon the Jury of Appeals. In the spring of 1879, by appointment of President Hayes, he became American minister to the German Empire, and in that post he remained till 1881.

After his resignation, in 1885, of the presidency of Cornell, he again crossed the Atlantic, and tarried in Europe till the spring of 1887. Returning, with renewed vigor, he had not yet entered on any serious work when the heaviest blow of his life, the unforeseen and almost instantaneous death of Mrs. White, threw all his plans into confusion. His married life had been singularly happy, and Mrs. White his almost constant companion. On the expedition to Santo Domingo he had been forced to leave her behind, and after the false rumor of the loss of the commissioners at sea, and the publication of their obituaries in the metropolitan journals, he had come back in safety to find her hair turned to snowy white. Now it was his turn to suffer, and the friends who saw him breaking beneath his grief persuaded him again to go abroad. There he lingered till the late summer of 1889; then, returning, he again took up his home in Ithaca, where—though he had declined the honorary presidency and the deanship of the School of History, which had in turn been tendered him by the university—he was still bound to Cornell by his duties as a trustee. And now, in 1892, there came to preside in his home a second wife, Miss Helen Magill, a daughter of President Magill, of Swarthmore—herself well known as scholar and as educator. In 1892 he was made, by President Harrison, minister of the United States at St. Petersburg, and, retained in that post by Mr. Cleveland, spent at the Russian capital the next two years. It was a pleasing visit, after forty years, to the scene of his earliest diplomatic experiences. His return to this country in 1895, and his appointment in January, 1896, to a place upon the important Commission of Inquiry into the Venezuelan boundary are fresh in the memory of all American readers.

In this busy life, so filled with the cares of the teacher, the politician, the man of affairs, there has been little leisure for the research that goes to the making of books; and few of the literary plans with which he began his career have been realized. His biography of Jefferson was never written. Of his long-dreamed-of history of the French Revolution, for which he collected a material unequaled on this side of the Atlantic, only his admirable little monograph on Paper Money Inflation in France, and his stimulating Bibliography of the Revolution, in the book of Judge Morris, are the visible results. Of his inspiring academic lectures on the general history of modern Europe, but two or three have seen the light as magazine articles; though their topical outlines, printed for his students and by them scattered abroad, have sug-

gested more than one book to younger scholars—as, for example, the excellent study of Mr. Lewis Rosenthal on America and France. The Manual of Historical Literature which Mr. White had proposed as a joint task to his pupil and successor, Prof. Charles Kendall Adams, had finally to be worked out alone by the latter. It is, indeed, as an inspirer of books that his activity has been greatest. Yet he has remained himself a wide reader and a tireless student; and not alone the addresses and magazine articles in which he has brought to bear so tellingly upon a host of present-day problems the fruits of a ripe historical scholarship, but at least one book of serious proportions will attest the quality of his work.

This book, so many of whose chapters are familiar to the readers of the Popular Science Monthly, is his Warfare of Science, or, to give it its full title, his History of the Warfare of Science with Theology in Christendom. It was in the troublous early days of Cornell, when the nonsectarian character of the university was bringing it from its rivals on every side the charge of godlessness, and when Mr. Cornell and Mr. White himself were rewarded for their labors by such epithets as infidel and atheist and by the suspicion of good Christian people everywhere, that it first occurred to him to find comfort and assurance in the study of this stage in the history of all the great intellectual movements through which civilization has been won. From its earliest form, as a mere lecture in 1875, it has grown through twenty years to the two stately volumes now about to be published. In the gathering of its materials, scattered over almost the whole territory of human knowledge, Mr. White has known how to use the aid from time to time of sundry helpers; but even in this preliminary labor his own immediate share has far outweighed all others, and in the digestion and interpretation of his materials no other hand was ever given a part. Clear as is his statement of its thesis, few books have suffered such misjudgment from careless or unkindly critics. What interested him was never the opinions, normal or abnormal, of forgotten theologians; but their interferences, in the mistaken interest of religion, with that freedom of thought and research out of which alone science can grow. Nor was he actuated by any hostility to religion. A man of profoundly religious nature, impatient of irreverence of any kind, and deeply attached to the Christian communion in which he was reared, he seeks only to lift the timid faith which dares not trust the God of the universe to deal truly with the human mind he has made to the loftier conviction that—in his own noble words—"there is a God in this universe wise enough to make all truth-seeking safe, and good enough to make all truth-telling useful."

PROFESSIONAL INSTITUTIONS.

X.—SCULPTOR.

By HERBERT SPENCER.

THE association between architecture, sculpture, and painting is so close that the description of their origins, considered as distinct from one another, is not easy; and those who judge only from the relations under which they are found in the remains of early civilizations are apt to be misled. Thus Rawlinson remarks that—

"Sculpture in Egypt was almost entirely 'architectonic,' and was intended simply, or at any rate mainly, for architectural embellishment. . . . The statues of the gods had their proper place in shrines prepared for them. . . . Even the private statues of individuals were intended for ornaments of tombs."

Here the implication appears to be that as, in historic Egypt, sculpture existed in subordination to architecture, it thus existed from the beginning. This is a mistake. There is abundant reason to conclude that everywhere sculpture, under the form of carving in wood, preceded architecture, and that the tomb and the temple were subsequent to the image.

In the first volume of this work (§§ 154–158) * evidence of various kinds, supplied by various peoples, was given proving that in its initial form an idol is a representation of a dead man, conceived as constantly or occasionally inhabited by his ghost, to whom are made offerings, prayers for aid, and propitiatory ceremonies. Confusion arising in the uncritical mind of the savage between the qualities of the original and the like qualities supposed to accompany a likeness of the original, long survived. Its survival was shown among the Egyptians by their seemingly strange practice of placing, in a compartment of the tomb, a wooden figure (or more than one) intended as an alternative body for the spirit of the departed on his return, in case his mummied body should have been destroyed. Still more strange is the fact referred to in the sections named above, that among ourselves and other Europeans but a few centuries ago, the effigies of kings and princes, gorgeously appareled, were duly presented with meals for some time after death: such effigies being, some of them, still preserved in Westminster Abbey. Merely recognizing this long persistence of the primitive idea, it here concerns us only to note that the making of a carved or modeled figure of a dead man begins in low stages of culture, along with other elements of primitive religion; and that thus sculpture has its root in ghost-worship,

* Principles of Sociology, vol. i.

while the sculptor, in his primitive form, is one of the agents of this worship.

The tomb and the temple are, as is shown in § 137,* developed out of the shelter for the grave—rude and transitory at first, but eventually becoming refined and permanent; while the statue, which is the nucleus of the temple, is an elaborated and finished form of the original effigy placed on the grave. The implication is that, as with the temple so with the statue, the priest, when not himself the executant, as he is among savages, remains always the director of the executant—the man whose injunctions the sculptor carries out.

Of evidence to be set down in support of this general proposition we may begin with that, relatively small in amount, which is furnished by existing uncivilized races.

Concerning the Gold Coast Negroes, Bosman tells us that they "generally build a small cottage or hut . . . on the grave," and also that in some parts "they place several earthen images on the graves." Bastian, writing of the Coast Negroes, says clay figures of departed chiefs with their families are placed in groups under the village tree. Nothing is added about the makers of these clay images; but in another case we find evidence of priestly origin. According to Tuckey, a certain fetich-rock on the Congo "is considered as the peculiar residence of Seembi, the spirit which presides over the river;" that on some of the rocks "are a number of raised figures," made of some composition which appears "like stone sculptured in low relief"—rude representations of men, beasts, ships, etc.: "they were said to be the work of a learned priest of Nokki who taught the art to all those who chose to pay him."

The Polynesian races yield some evidence: relevant facts are narrated of the Sandwich Islanders by Cook and Ellis. The one describes the burying places as containing many wooden images representing their deities, some in huts, others not; and the other tells us that "each celebrated tii [spirit] was honored with an image." That these celebrated spirits were originally the ghosts of deceased chiefs, is implied by the account given of an allied Polynesian race, the New Zealanders. Among these, according to Thomson, the bodies of chiefs, in some cases "interred within the houses where they died," where they were bewailed by relatives for weeks [a rude temple and a rude worship], had "rude human images, twenty or forty feet high," erected as monuments to them. Though in neither of these cases are we told by whom such images of deceased men were made, yet since of New Zealand artists the best are found among the priests, as asserted by

* Principles of Sociology, vol. i.

Thomson, while Angas tells us that the priest is generally the operator in the ceremony of tattooing, he being supposed to excel in all sorts of carving, the implication is that he is the maker of these effigies—in the cases of chiefs, if not in other cases. For while it is alleged that the house-posts, rudely representing deceased members of an ordinary family, are made by members of the family, we have, in the special characters of the effigies made of chiefs, evidence that priests have been the executants. Dr. Ferdinand von Hochstetter says:—

"The carved Maori-figures, which are met with on the road, are the memorials of chiefs who, while journeying to the restorative baths of Rotorua, succumbed to their ills on the road. Some of the figures are decked out with pieces of clothing or kerchiefs; and the most remarkable feature in them is the close imitation of the tattooing of the deceased, by which the Maoris are able to recognize for whom the monument has been erected. Certain lines are peculiar to the tribe, others to the family, and again others to the individual."

As the priests are the professional tattooers, probably being also the authorities concerning tribal and family marks, it is a fair inference that they are the makers of these images of chiefs, in which the tribal, family, and individual marks are represented.

Certain usages have been found among the Australians which, if not directly relevant, are indirectly relevant. At an initiation ceremony in the Murring tribe, according to Howitt—

"A similar rude outline of a man in the attitude of the magic dance, being also Daramūlŭn, is cut by the old men (wizards) at the ceremonies, upon the bark of a tree at the spot where one of them knocks out the tooth of the novice. . . .

"At a subsequent stage of the proceedings a similar figure is molded on the ground in clay, and is surrounded by the native weapons which Daramūlŭn is said to have invented."

Here the obvious implication is that the traditional hero, Daramūlŭn, is represented by the figures which the wizards (medicine-men or priests) make; while the initiation ceremony is the dedication of the novice to him, considered as present in the figure: to which figure, indeed, a road is marked out on the tree, down which Daramūlŭn is supposed to descend to the image.

By the above-named house-posts which, among the New Zealanders, are erected as memorials of members of the family, we are introduced to the further set of illustrations furnished by household gods. These the accounts of various races in various parts of the world make familiar.

Concerning the Kalmucks and Mongols, who have such domestic idols, Pallas tells us that the priests are the painters, as well as the makers, of images of copper and clay.

According to Ellis the idol-worship of the Malagasy "appears to have sprung up in comparatively modern times, and long sub-

sequently to the prevalence of the worship of household gods." But who were the makers of either does not appear.

How it would naturally happen that while, in the first stages, the priest was the actual carver of images, he became, in later stages, the director of those who carved them, will be easily understood on remembering that a kindred relation between the artist and his subordinate exists now among ourselves. The modern sculptor does not undertake the entire labor of executing his work, but gives the rough idea to a skilled assistant who, from time to time instructed in the needful alterations, produces a clay model to which his master gives the finished form: the reproduction of the model in marble by another subordinate being similarly dealt with by the sculptor. Evidently it was in something like this sense that priests throughout the East were sculptors in early days, as some are in our own days. Writing of the Singhalese, Tennent says:—

"Like the priesthood of Egypt, those of Ceylon regulated the mode of delineating the effigies of their divine teacher, by a rigid formulary, with which they combined corresponding directions for the drawing of the human figure in connection with sacred subjects."

From Egypt, here referred to, may be brought not only evidence that the sculptured forms of those to be worshiped were prescribed by the priests in conformity with the traditions they preserved, but also evidence that in some cases they were the actual executants. Mentu-hotep, a priest of the 12th dynasty, yields an example.

"Very skilled in artistic work, with his own hand he carried out his designs as they ought to be carried out." He "besides was invested with religious functions" and "was the *alter ego* of the king." His inscription says:—"I it was who arranged the work for the building of the temple."

An inscription of the 18th dynasty refers to one Bek, architect of Amenhotep IV, who being described as "the follower of the divine benefactor" was apparently a priest, and who was both an executant and a supervisor of other's work. He is referred to as—

"overseer of the works at the red mountain, an artist and teacher of the king himself, an overseer of the sculptors from life at the grand monuments of the king for the temple of the sun's disk."

A further fact is given. Bek says of himself—"My lord promoted me to be chief architect. I immortalized the name of the king . . . [I caused] to be made two portrait-statues of noble hard stone in this his great building. It is like heaven. . . . Thus I executed these works of art, his statues."

What evidence Greek records yield, though not extensive, is to the point. Curtius, who, referring to actions of the singers

and composers of hymns as well as to those of the plastic artists, says that "the service of the temple comprehends the whole variety of these efforts," also says that "the earliest sculptors were persons of a sacerdotal character." On another page he adds, concerning sculpture—

". . . in this domain of artistic activity, all things were bound by the decrees of the priests and by close relations with religion. . . . They [artists] were regarded as persons in the service of the divine religion."

The extent to which sculpture subserved religious purposes may be judged from the statement of Mahaffy that—

"The greatest sculptors, painters, and architects had lavished labor and design upon the buildings [of the oracle at Delphi]. Though Nero had carried off 500 bronze statues, the traveler estimated the remaining works of art at 3,000, and yet these seem to have been almost all statues."

As showing the course of professional development it may be remarked that though, in archaic Greek sculpture, the modes of representing the various deities were, as in Egypt and India, so completely fixed in respect of attitudes, clothing, and appurtenances that change was sacrilege, the art of the sculptor, thus prevented from growing while his semi-priestly function was under priestly control, simultaneously began to acquire freedom and to lose its sacred character when in such places as the pediments of temples, figures other than divine, and subjects other than those of worship, came to be represented. Apparently through transitions of this kind it was that sculpture became secularized. Men engaged in chiseling out statues and reliefs in fulfillment of priestly dictates were regarded simply as a superior class of artisans, and did not receive credit as artists. But when, no longer thus entirely controlled, they executed works independently, they gained applause by their artistic skill and "became prominent celebrities, whose studios were frequented by kings.

To the reasons, already more than once suggested, why in Rome the normal development of the professions was broken or obscured, may be added, in respect of the profession of sculptor, a special reason. Says Mommsen:—

"The original Roman worship had no images of the gods or houses set apart for them; and although the god was at an early period worshiped in Latium, probably in imitation of the Greeks, by means of an image, and had a little chapel (*aedicula*) built for him, such a figurative representation was reckoned contrary to the laws of Numa."

The appended remark that the representation of the gods was "generally regarded as an impure and foreign innovation" appears to be in harmony with the statement of Duruy.

"Even after the Tarquins, the images of the gods, the work of Etruscan artists, were still made only in wood or clay, like that of Jupiter in the Capitol, and like the quadriga placed on the top of the temple."

The contempt felt by the Romans for every other occupation than the military, and the consequent contempt for art and artists imported from conquered peoples, resulted in the fact that in the time of the Cæsars sculptors and painters "were generally either slaves or freedmen." Probably the only concern the priests had with sculpture was when prescribing the mode in which this or that god should be represented.

Such records as have come down to us from early Christian times illustrate the general law of evolution in the respect that they show how little the arts of design were at first specialized. It has been often remarked that in days comparatively modern, separation of the various kinds of mental activity was much less marked than it has since become: instance the fact that Leonardo da Vinci was man of science as well as artist; instance the fact that Michael Angelo was at once poet, architect, sculptor and painter. This union of functions seems to have been still more the rule in preceding ages. Evidence about the sculptors' art is mingled with evidence about kindred arts. Says Emeric-David—"The same masters were goldsmiths, architects, painters, sculptors, and sometimes poets, as well as being abbots or even bishops." We are told by Challamel that the industrial art by pre-eminence was gold-working. The great artists in it were monks or at least clerics. The great schools of it were monasteries. And it was for the use of churches—ecclesiastical vestments and decorations, funeral monuments, etc.

In the last part of this statement we see the implication that the sculpturing of figures on monuments was a priestly occupation. This is also implied by the statement of Emeric-David that in the 10th cent. Hugues, monk of Monstier-en-Der, was painter and statuary. Further proof that miscellaneous art-works were carried on by the clerical class is given by Lacroix and Seré, who say that early in the 11th cent. a monk, named Odoram, executed shrines and crucifixes in gold and silver and precious stones. In the middle of the century another monk, Theophilus, was at once painter of manuscripts, glass-stainer, and enameling goldsmith.

Concerning these relationships in England during early days, I find no evidence. The first relevant statements refer to times in which the plastic arts, which no doubt were all along shared in by those lay-assistants who did the rough work under clerical direction—such as chiseling out monuments in the rough according to order—had lapsed entirely into the hands of these lay-assistants. Having been in the preceding times nothing but skillful artisans, their work, when it came to be monopolized by them, was for a long time regarded as artisan-work. Hence the statement that—

"Previously to the reign of Charles I the sculptor seems hardly to have been considered an artist." "Nicholas Stone was the sculptor most in vogue. He was master-mason to the king."

I may add that in early days, monks—St. Dunstan being an example—occupied themselves in executing the details of ecclesiastical buildings—the foliations of windows, screens, and the like. It is said that when sculpturing the heads used for gargoyles, they sometimes amused themselves by caricaturing one another.

Recent stages in the development of sculpture are not easy to trace. But there seems to have occurred in modern times a process parallel to that which we saw occurred in Greece. During the first stages in the secularization of his business the carver of marble carried with him the character previously established—he was a superior artisan. Only in course of time, as his skill was employed for other than sacred purposes, did he become independent and begin to gain reputation as an artist. And his position has risen along with the devotion of his efforts more and more to subjects unconnected with religion.

Let it be observed, however, that even still sculpture retains in considerable measure its primitive character as an ancillary to ancestor-worship. A carved marble effigy in a Christian church differs but little in meaning from a carved wooden figure of a dead man placed on his grave in savage and semi-civilized societies. In either case the having an image made, and the subsequent conduct in presence of it, imply the same prompting sentiment: there is always more or less of awe or respect. Moreover, sculpture continues to be largely employed for the expression of this sentiment, not in churches only, but in houses. The preservation of a bust by descendants commonly implies recognition of worth in the original, and is thus in a faint way an act of worthship.

Hence only that kind of sculpture which is not devoted to the representation of deceased persons, in either public or in private edifices, or in open places, can be considered as absolutely secularized. One who takes his subjects from ancient myth, or history, or from the life around, may be considered as alone the sculptor who has lost all trace of the original priestly character.

With recognition of the completed process of differentiation there is nothing here to join respecting the process of integration. Sculptors have not yet become sufficiently numerous to form entirely independent unions. Such combination as has arisen among them we shall have to recognize in the next chapter, in association with the combinations of painters.

LORD SALISBURY ON EVOLUTION.*

By HERBERT SPENCER.

ENTHUSIASTIC adherents have compared the principle of natural selection with the principle of gravitation. The comparison is not warranted. In the first place the one is far from having a like cardinal value with the other as a scientific truth; and in the second place it is not the sole cause of the phenomena to be explained, as Mr. Darwin himself admitted when recognizing the inherited effects of use and disuse. Nevertheless, after making these reservations, I will for a moment adopt the comparison; because, by its aid, I shall be enabled clearly to show the nature of a widely prevalent misconception.

Let us suppose that our days were the days when Newton had lately propounded his theory, and that the newspaper reader (or as there were few such in those days, let us say "the man in the street") had been told about it. Suppose it had been explained to him that, according to Newton, bodies attract one another directly as their masses and inversely as the squares of their distances, and that the phenomena presented by the Solar System had been accounted for by him as conforming to this law. Suppose that presently the man, thus far instructed, learned that there were skeptics: Clairaut, for instance, having found that certain of the Moon's motions could not be explained as results of gravitation, and that consequently Newton's interpretation of planetary motions was untenable. Now suppose the man inferred that along with the theory of gravitation the theory of the Solar System must be abandoned; and that certain views of Copernicus, of which he had heard, and certain other views of Kepler, had been disproved. What, in such case, should we say? Evidently that the man made a profound mistake in identifying the theory of gravitation with the theory of the Solar System. We should say that there were independent reasons for accepting the Copernican system and the laws of Kepler; and that though, were the law of gravitation disproved, the pre-existing theory of the Solar System would lack that rational interpretation which the law of gravitation gave to it, yet it would remain standing on conclusive evidence.

Mr. Darwin's doctrine of natural selection and the doctrine of organic evolution are, by most people, unhesitatingly supposed to be one and the same thing. Yet between them there is a difference analogous to that between the theory of gravitation and the theory of the Solar System; and just as the theory of the Solar

* Inaugural Address to the British Association, 1894.

System, held up to the time of Newton, would have continued outstanding had Newton's generalization been disproved, so, were the theory of natural selection disproved, the theory of organic evolution would remain. Whether it were shown that natural selection is inoperative, or whether it were shown that though a partial cause it is inadequate to explain all the facts (the inheritance of functionally-wrought modifications being a co-operative cause); or whether it were shown that no cause hitherto alleged is adequate; the general doctrine that organisms of all kinds have arisen by the continual superposing of modifications upon modifications would maintain its place, though it would not be fortified so strongly. Lord Salisbury, however, in common with the immense majority of men, assumes that the hypothesis of organic evolution must stand or fall with its alleged causal agencies. Though in one paragraph he distinguishes between natural selection as an alleged agent, and the facts regarded as implying evolution which are said to be explained by it, yet, at the close of his address, he assumes the two to be so indissolubly connected that, if natural selection goes, evolution must go with it—that the facts are not naturally explicable at all, but must be regarded as supernatural. He says, referring to Prof. Weismann:—"I quite accept the Professor's dictum that if natural selection is rejected we have no resource but to fall back on the mediate or immediate agency of a principle of design." And thus he indorses the popular notion that Darwinism and Evolution are equivalent terms.

Though, speaking on behalf of biologists, who are conscious of the difference, Prof. Huxley, in seconding the vote of thanks, demurred to this identification, yet the above-quoted sentence reappears in the revised and republished form of Lord Salisbury's address.

Absence of direct proof of natural selection is duly emphasized by Lord Salisbury. He says:—"No man or succession of men have ever observed the whole process in any single case, and certainly no man has recorded the observation." And, as direct proof of the hypothesis is not forthcoming, it is tacitly assumed that we must accept the alternative hypothesis, which is equally without direct proof. Here I may be excused if, *à propos* of this position, I reproduce some passages from an essay published in pre-Darwinian days, when the development hypothesis, as it was then called, was universally ridiculed. The first part of the essay runs as follows:—

In a debate upon the development hypothesis, lately narrated to me by a friend, one of the disputants was described as arguing that as, in all our experience, we know no such phenomenon as transmutation of species, it is unphilosophical to assume that transmutation of species ever takes place.

Had I been present I think that, passing over his assertion, which is open to criticism, I should have replied that, as in all our experience we have never known a species *created*, it was, by his own showing, unphilosophical to assume that any species ever had been created.

Those who cavalierly reject the Theory of Evolution as not being adequately supported by facts, seem to forget that their own theory is supported by no facts at all. Like the majority of men who are born to a given belief, they demand the most rigorous proof of any adverse belief, but assume that their own needs none. Here we find, scattered over the globe, vegetable and animal organisms numbering, of the one kind (according to Humboldt), some 320,000 species, and of the other, some 2,000,000 species (see Carpenter); and if to these we add the numbers of animal and vegetable species which have become extinct, we may safely estimate the number of species that have existed, and are existing, on the Earth, at not less than *ten millions*. Well, which is the most rational theory about these ten millions of species? Is it most likely that there have been ten millions of special creations [each implying a conscious design and acts in pursuance of it]? or is it most likely that, by continual modifications due to change of circumstances, ten millions of varieties [i. e. kinds] have been produced? . . .

Doubtless many will reply that they can more easily conceive ten millions of special creations to have taken place, than they can conceive that ten millions of varieties have arisen by successive modifications. All such, however, will find, on inquiry, that they are under an illusion. . . . Careful introspection will show them that they have never yet realized to themselves the creation of even *one* species. If they have formed a definite conception of the process, let them tell us how a new species is constructed, and how it makes its appearance. Is it thrown down from the clouds? or must we hold to the notion that it struggles up out of the ground? Do its limbs and viscera rush together from all the points of the compass? or must we receive the old Hebrew idea, that God takes clay and molds a new creature? . . .

Should the believers in special creations consider it unfair thus to call upon them to describe how special creations take place, I reply that this is far less than they demand from the supporters of the development hypothesis. They are merely asked to point out a *conceivable* mode. On the other hand, they ask, not simply for a *conceivable* mode, but for the *actual* mode. They do not say—Show us how this *may* take place; but they say—Show us how this *does* take place. So far from its being unreasonable to put the above question, it would be reasonable to ask not only for a *possible* mode of special creation, but for an *ascertained* mode; seeing that this is no greater a demand than they make upon their opponents.

It is true that the contrast of evidences here emphasized refers not to the theory of the origin of species through natural selection, which at that time (1852) had not been propounded, but refers to the theory of organic evolution considered apart from any assigned causes, or rather, as due to the general cause—adaptation to conditions. The contrast remains equally strong, however, if, instead of the general doctrine the special doctrine is in question; and the demand for facts in support of this special doc-

trine may similarly be met by the counter-demand for facts in support of the doctrine opposed to it. Perhaps Lord Salisbury will meet this demand by quoting the statements contained in the book of Genesis. But even if, ignoring the skepticism of professed biblical critics, such as the Rev. Prof. Cheyne, he puts absolute faith in these statements current among nomadic groups of shepherds three thousand years ago, he is obliged to admit that these alleged facts are not of the class he refers to when he asks for proof of the hypothesis of natural selection: they are not facts of direct observation.

Thus, supposing the two hypotheses—special creation and evolution by natural selection—are to be tested by the directly observed facts assigned in their support, then, if the hypothesis of evolution by natural selection is to be rejected because there are no directly observed facts which prove it, the hypothesis of special creation must be rejected for the same reason. Nobody has seen a species evolved and nobody has seen a species created.

But now from the question of direct evidence let us pass to the question of indirect evidence. Let us ask if there are any positive facts of observation which tend to justify the one, and whether there are any positive facts of observation which tend to justify the other. Here a comparison leads to widely different results. Familiar though some of the facts are, I must be excused for specifying them, since Lord Salisbury ignores them.

Though, because most of the geological record has been destroyed while the remnant has been dislocated or blurred, and because so small a part—an infinitesimal part—of this remnant has been examined, paleontology furnishes but broken evidence, yet the more the Earth's strata are examined the more they testify that organic forms have arisen by modifications upon modifications. Recent discoveries, especially those which show by intermediate forms that the bird-type is derived from the reptile-type, and those which show that, beginning with the four-toed *Orohippus* of the Eocene strata, we ascend in later strata, through *Mesohippus*, *Miohippus*, *Protohippus*, and *Pliohippus*, up to the modern horse, have given strong support to the hypothesis of evolution: support so strong that Prof. Huxley, who had up to the time he saw Prof. Marsh's fossils made reservations in his acceptance of the hypothesis, thereafter accepted it without reserve. Not only do fossils furnish in this and other cases the lines of linear ascent to existing forms, but they simultaneously disclose a general fact of great significance—the fact that early types of creatures in any class display the commonest or most general traits of structure, and that later types of the same class are more specialized in this or that direction: relationships which are neces-

sarily implied by the evolutionary process of divergence and redivergence with accompanying modifications.

The truths of classification, again, have a kindred meaning. Ordinary people, and even naturalists of the old school, pass by as of no significance the remarkable relations which, in both plant and animal kingdoms, exist among their divisions, subdivisions, and sub-subdivisions—their classes, subclasses, cohorts, orders, genera, species, varieties. The fact that these fall into groups within groups, successively decreasing in size, consists perfectly with the supposition of common origin. Suppose an arm of a large tree to have been buried in such wise as to leave only the tips of its twigs visible; and suppose a man from the Faroe Isles, ignorant of trees, taking one of these protruding tips for a separate plant, attempted to uproot it. He would find that below the surface the twig he uncovered joined with others like itself to form a small branch; and explorations all around would prove that everywhere the local clusters of twigs thus converged. Further excavations would show that the adjacent branchlets, composed of clusters of twigs, themselves united a little deeper down, and were subdivisions of a medium-sized branch. Again digging he would discover that several such branches formed parts of a still larger branch; and so on continually, until complete clearance made it manifest that all these great branches, small branches, branchlets, and twigs, in their respective groups, had diverged from the one original arm of the tree, which itself had diverged from the stem; and that they formed groups within groups diminishing in size as they became more remote from their common parent. And now observe that while there are thus symbolized the relationships of species, genera, orders, etc., as they now exist, there are also symbolized the relationships which, so far as we know ther exist among remains contained in the Earth's crust: the two sets of phenomena correspond.

The lesson taught by the facts of distribution in Time, is also taught by the facts of distribution in Space. In various regions there are alliances between the present fauna and the past fauna found fossil: though different, they are near akin. It was "this wonderful relationship in the same continent between the dead and the living" which especially forced on Mr. Darwin the belief in descent and modification: this relationship having been demonstrated by Prof. Owen between the existing South American forms and the buried forms of extinct species. The fact that in Australia, long cut off from the other continents, all the indigenous mammals are of the implacental type, and that the fossil mammals found there are also exclusively implacental, illustrates these connections very clearly. And these likenesses of nature between present faunas and past faunas in the same localities are

implications agreeing exactly with the implications pointed out above.

Once more there are the facts of embryology. In various ways these tell us with endless repetition the same story.

Von Baer "found that in its earliest stage, every organism has the greatest number of characters in common with all other organisms in their earliest stages; that at a stage somewhat later, its structure is like the structures displayed at corresponding phases by a less extensive multitude of organisms; that at each subsequent stage, traits are acquired which successively distinguish the developing embryo from groups of embryos that it previously resembled—thus step by step diminishing the class of embryos which it still resembles; and that thus the class of similar forms is finally narrowed to the species of which it is a member."

Obviously these groups, dividing and subdividing into smaller ones as they diverge and re-diverge, correspond completely to the groups within groups which the classifications of animals and plants show us, and with the groups within groups of the buried branch, which symbolize both their relations and the relations of fossil forms, so far as we know them. That is to say, what we may call the embryological tree corresponds with the classificatory tree, and with those more modern parts of the paleontological tree which we have been able imperfectly to trace. Moreover, if we accept the hypothesis of evolution, the strange transformations undergone by a developing embryo become intelligible, though otherwise unintelligible. Every superior animal commences as a nucleated cell, a form common to the smallest and simplest creatures, the *Protozoa*. While, among the *Protozoa*, this nucleated cell, by undergoing fission gives rise to others which part company (which derived cells again divide and part company), the trait common to the *Metazoa* is that, instead of parting company, the cells formed by successive fissions remain together and constitute a cluster. The members of this cluster divide into two layers, between which, in higher types, there arises a third; and from these all the external and internal organs are formed. In each great class of *Metazoa*, further development of each higher type is accompanied by a "recapitulation" of traits distinctive of lower types. In the *Vertebrata*, for instance, the embryo of a bird or a rabbit has, at one time, traits resembling those of the fish-embryo—structures roughly representing gill-clefts being one. And in the case of the human embryo, it is only after exhibiting successive kinships of organization to lower mammals, that it at last assumes the form proper to man. Marvelous as is this repetition of traits belonging to lower types, rudely indicated, it is quite congruous with the hypothesis of evolution—implies a kind of transcendental heredity. On the other hand, the hypothesis of design furnishes no explanation, but presents an insurmountable difficulty. For if the development of the

embryo had been divinely arranged, it would surely have gone along lines of direct growth from the germ to the finished form: would not have displayed various metamorphoses having no relations either to passing needs or to ultimate structure and mode of life. With which evidence may be joined the evidence furnished by rudimentary organs, which are full of meaning on the evolution hypothesis, but worse than meaningless in the special-creation hypothesis.

But these four great groups of facts, suggesting in different ways the same history, stand thus far without assigned cause. How come these progressive modifications to have taken place? and why are the modified forms connected with one another in the ways shown alike by paleontology, by classification, by distribution, and by embryology? The reply is that we need only look around to see everywhere at work a general cause which, if it has been at work throughout all time, yields an explanation. Take any plant or animal and expose it to a new set of circumstances (circumstances not so unlike its previous ones as to prove fatal), and it begins to change; and the change is one which eventually adapts it to the new conditions. By what special causes the adaptive modifications are effected does not at present concern us. Here the argument requires us only to recognize the truth that in some way the organization is molded to the new conditions. Though—to illustrations furnished by cultivated plants and domesticated animals—it may be objected that artificial selection has been at work, yet, since artificial selection implies variations, it implies that the selected plants and animals have been modified by external influences, and that the modifications have been inherited and accumulated. And then, if there needs a case in which artificial selection has not come into play, we have a sufficiently striking one in the human race itself. Unless there be adopted the hypothesis (excluded by Lord Salisbury's implied belief) that varieties of men have been independently created, the conclusion is irresistible that their differences have been caused by unlikenesses in their lives carried on in unlike environments. Either their differences are uncaused, which is absurd, or they are differences which have *un*fitted each variety for its conditions, which is also absurd, or they are differences which have fitted each variety for its conditions; and, if so, they have resulted from the response of the constitution to the conditions themselves: the only supposition which is not absurd. And that this is the necessary interpretation is shown by cases in which—either by the killing off of unfit individuals, or by the effects of habit, or by both—extraordinary adaptations have been produced. There are, as examples, the Fuegians, who in their wretched islands go about naked while the falling snow melts on

their bodies; there are the Yakutes—the "iron men," as they are called—who, in their rigorous climate, sleep in the open air and wake covered with hoar-frost; there are the Hindus, constitutionally adjusted to the tropics in such way that they can sleep in the burning sunshine; and, again, there are Indian hill-tribes living comfortably in malarious localities which are fatal not only to Europeans but to Hindus. Moreover, while we thus get proof that organisms fit themselves to their environments, we also get proof that there simultaneously result divergences and re-divergences of races and varieties. Men have spread from some original locality into other localities in all directions; and there have resulted sundry widely unlike families appropriate to their respective habitats, and less unlike breeds diverging within them, such as the Aryan peoples of Europe. This process which the human species shows us is, and always has been, the process with every kind of organism. While we are shown a general cause which has been superposing modifications upon modifications from the beginning, we are also shown how there has arisen a concomitant formation of class within class. The cause we find in operation is a cause of the kind needed to explain the remarkable relations above described.

Thus we have four great groups of observed facts (or five if we include those concerning rudimentary organs) all suggesting the same history, all converging to the same conclusion: their joint significance being immense in comparison with the significance of each group taken by itself. And in the adaptation of organisms to their conditions, directly or indirectly brought about, we have a cause which makes these aggregates of phenomena intelligible. On these mutually-verifying sets of evidences the hypothesis of evolution stands by itself, quite apart from any conclusions respecting its special causes. Hence the meaning of the assertion made above, that even were all theories about the special causes disproved, the doctrine of evolution would remain standing.

And now, having contemplated the observed facts which indirectly support the hypothesis of evolution, let us ask for the observed facts which indirectly support the alternative hypothesis. There are none. Neither in the air, nor on the earth, nor in the water do we find anything implying special creation. Nay, indeed, not only do we see no facts favoring the supposition, but we see a world of facts conflicting with it. From hour to hour incidents showing the uniformity of law and the constant relations of causes and effects generate in us convictions so incongruous with it as to produce instant disbelief of an alleged special creation now occurring. Should any one say that having taken into his room a bowl containing nothing but clear water, he saw a fish

suddenly appear in it; or should he say that he had seen near the ground a mass of cloud which, contracting and getting more dense, assumed the form of an unknown animal, what comment should we make? Simply that he was either deluding himself or trying to delude us. We should show by our ridicule that the idea of a special creation, when brought distinctly before us by alleged cases, is too absurd to be entertained.

See, then, the antithesis. While the hypothesis of organic evolution is indirectly supported by great masses of observed facts, the hypothesis of special creation is not only without indirect support from observed facts, but is indirectly contraindicated by the enormous accumulation of observed facts constituting our daily experience.

Striking as this antithesis is, it becomes still more striking when we contemplate the two hypotheses under another aspect. Lord Salisbury implies that in the absence of observed facts directly proving the formation of a species by natural selection, the hypothesis of natural selection can not be sustained. He says:—"I think Prof. Weismann is justified in saying that we can not, either with more or less ease, imagine the process of natural selection"; and he presently implies that in the absence of positive proof the hypothesis of natural selection is "mere conjecture." Let me in the first place point out that Prof. Weismann's meaning is here seriously misrepresented. In the passage Lord Salisbury refers to, Prof. Weismann says of natural selection:—"We accept it—not because we are able to demonstrate the process in detail; not even because we can with more or less ease imagine it [in detail], but simply *because we must*, etc." And that this is his meaning is proved by the fact that a previous passage to which he refers by the words "as already indicated," runs as follows:—"For *it is really very difficult to imagine this process of natural selection in its details.*" Surely there is an immense difference between the meaning intended and the meaning ascribed. It is perfectly easy to imagine that a flying cannon-ball will presently fall and do damage, while it may be "very difficult to imagine," "in its details," the damage it will do. But, passing over this, let us now consider whether, in the absence of observed facts proving the production of a species by natural selection, we have warrant for the theory of natural selection.

I have always regretted that Mr. Darwin chose this phrase to describe his hypothesis. The word "selection" connotes a *conscious process*, and so involves a tacit personalization of Nature. By tacitly personalizing that aggregate of surrounding agencies which we call Nature, it introduces vaguely the idea that Nature may select as a human breeder selects—can select and increase a

particular quality—which is true only under certain conditions. Further, it raises the thought of choice—suggests the notion that Nature may or may not operate in the alleged way.

It was partly the consciousness that wrong ideas are called up in these ways which led me, when writing *The Principles of Biology*, to substitute the phrase "survival of the fittest"—partly, I say, because, as is shown in § 164 of that work, the phrase naturally emerges when we contemplate, from a purely physical point of view, the phenomena of life and death in connection with surrounding actions. My belief is that had Mr. Darwin used this phrase, many misunderstandings of his theory would never have arisen, and many objections to his inferences would have been excluded. Among other excluded objections would have been that raised by Lord Salisbury, who thinks that, lacking a basis of observed facts, the hypothesis of natural selection has no basis. For if we substitute the phrase "survival of the fittest," it becomes manifest that the process is a necessary one. To see this it needs but to affirm the opposite and say that the law is survival of the unfittest—that those creatures which were fit to live have died, and those have lived which were unfit to live. These statements embody a contradiction. Hence survival of the fittest is inevitable—is just as certain a truth as a mathematical axiom, which we accept because the negation of it is inconceivable.

Heredity, otherwise manifest, being clearly proved by the experience of breeders, survival of the fittest necessarily implies that those individuals which have structures best adapted to their environments, will, on the average, have better adapted posterity than the rest; and that so the fitness to the environment will be maintained. A further unavoidable corollary is that if the habitat changes in character, or if there occurs a migration to another habitat, the most unfitted will disappear in a greater proportion than the least unfitted; and that from destruction of the most unfitted in successive generations, there will result a continually-diminished unfitness to the new habitat, until there is reached a fitness for it. These are inferences which it is impossible to escape.

Whether by this process a particular variation will be perpetuated and increased, is quite another question. The answer depends on the answer to another question—in what degree, all things considered, does the particular variation conduce to maintenance of life? But while the survival and multiplication of individuals having some advantageous modification of structure, is not a necessary result, the survival and multiplication of individuals having natures, or *aggregates of characters*, which best fit them to the requirements of their lives, *is* a necessary result; and it is a necessary truth that this involves the establishment of a

varied structure where this in a predominant degree aids them in fulfilling the vital requirements of their lives.

Mark, now, how the strong contrast set forth in the preceding section is thus strengthened. We saw that the evolution-hypothesis is indirectly supported by five great classes of observed facts; and that the perpetual adaptation and re-adaptation of constitution to conditions is a general cause of the kind required to account for these facts. Here we see that, of the special causes which effect adaptation, the chief one, survival of the fittest, is not only one the operation of which we can clearly conceive, but one which it is impossible to conceive as not operating. On the other hand, we saw that there are absolutely no observed facts which yield indirect support to the hypothesis of special creation; but that, contrariwise, all the observed facts of daily experience, proving a constant order among phenomena, negative the hypothesis. And we also saw that while the process of special creation can not be rationally conceived, the negation of it is perfectly conceivable. Thus, bringing the contrast to a focus, it appears that the one is credited both *a posteriori* and *a priori*, and the other is discredited both *a posteriori* and *a priori*. No stronger contrast in credibility can well be imagined.

Authoritative expositions of the process of natural selection afford no basis for that burlesque of it with which Lord Salisbury amused the public. The *Origin of Species* does not assume, as a requisite, the chance meeting of similarly varied individuals; and in Chapters III. and VI. of Mr. Wallace's *Darwinism*, where are assigned evidences which have accumulated since Mr. Darwin wrote, there are described processes quite other than that which Lord Salisbury describes. After referring to artificial selection, and implying that the success of breeders in producing a desired variety depends on their skill "in bringing the right mates together," he goes on to ask:—

"But in natural selection who is to supply the breeder's place? . . . What is to secure that the two individuals of opposite sexes in the primeval forest, who have been both accidentally blessed with the same advantageous variation, shall meet, and transmit by inheritance that variation to their successors?"

Even in the absence of the expositions above referred to, knowledge of familiar facts should have excluded this representation of the requirements. The contents of stud-books and herd-books might have been expected to suffice. It needs but to remember the care with which is specified a descent from some noted sire which lived several generations ago, to recognize the prevailing belief that a variation existing in a particular animal is transmitted in a greater or less degree to posterity, quite apart

from the possession of the same variation by the animal with which it is mated; and this belief is held by men who, as breeders, stake large profits on its truth. How, then, can it be said that without the union of two similarly varied individuals, "the new breed would never even begin, let alone the question of its perpetuation after it had begun." And here, to show still more clearly how experience negatives Lord Salisbury's assumption, let me give some evidence furnished not by domestic animals, but by human beings. Referring to a controversy which I have recently been carrying on with Prof. Weismann, Dr. Lindsay Johnson, F. R. C. S., who practices as an ophthalmic surgeon, and who tells me that the experience of other oculists verifies his own, testifies to the transmission of acquired myopia through several generations. He says (I quote with his permission):—

"I have seen a very large number of myopic patients who have had long-sighted parents and grandparents, but who have, during their studies or occupations, acquired a considerable degree of short sight and astigmatism, and then having had children from a normal or long-sighted wife (with normal-sighted parents and grandparents) it has been found that several of these children have grown up myopic and perpetuated it to their offspring again."

And he sends me a genealogical tree showing that in a family of six children descending from long-sighted ancestry on both sides, four remained normal-sighted, but two, who were miniature painters, became myopic. Of these one, marrying a normal-sighted wife, had two children, of whom one was myopic; and the other, marrying also a normal-sighted wife, had three children, all myopic. Two of these three married normal-sighted wives, and among their children there was in each case one who had become myopic, while the rest are as yet too young to display the defect, for it never occurs until after eight years old. That the inherited trait is in this case one caused by use, and not one arising spontaneously, does not affect the issue. There is proof that a modification of structure existing in one parent may descend to children when no similar modification is possessed by the other parent; and, further, that this modification may be re-transmitted, also without the aid of the second parent: facts which negative Lord Salisbury's assumption.

Let us now consider what is the corollary as respects modification of varieties and formation of species. Travelers tell us that the Bushmen are so long-sighted that they can see as far with the naked eye as a European can with a telescope. Allowing for some exaggeration, it is safely to be inferred that they have marvelous powers of discerning objects at great distances. How has this trait arisen? Small men as they are, wandering about in single families, Bushmen have to guard against enemies, brute and hu-

man, and must be ever on the alert to kill or snare animals serving for food. To identify distant moving objects as such or such, is therefore essential to the preservation of life. Here is one who, perhaps from some advantageous variation in the forms of the lenses, or in the adjusting muscles, or in the retinal elements, has vision so keen that he recognizes a man, or a lion, or a springbok, when its distance is half a mile greater than that at which other Bushmen can recognize it. What happens? He is enabled the sooner to take measures for his safety, or to make preparations for a hunt; and in either case has an increased chance of preserving life. By his wife, who has but the ordinary keenness of vision, he has children, some of whom, if not all of whom, inherit this peculiarity; and for the same reasons as before, these have, other things equal, better chances of surviving than the rest. If among their descendants some have the peculiarity in an increased degree, if some inherit it in the same degree, and others in smaller degrees in consequence of intercrossing, there will be a tendency, in virtue of the more frequent survival of individuals who are wholly inheritors or partially inheritors, to increase the distance-vision of the tribe: the stirp will spread more than other stirps. So that even were there no other way of establishing a variation save inheritance from a single varying individual, we may see how it will, if of life-saving efficiency, become established.

But there *is* another way in which variations become established. Creatures inhabiting the same region as the Bushmen furnish an illustration. The general structure of the giraffe is interpretable only as resulting from the co-operation of both factors in the production of species: the selection of variations and the inheritance of acquired characters. But there is one trait of structure attributable to natural selection alone. The giraffe has a prehensile tongue, almost snakelike in form. This it curls round the small branches of trees and pulls them into its mouth. So that, other things equal, a giraffe with an unusually long tongue is able to obtain twigs and clusters of leaves that are beyond the reach of those not similarly endowed; and, when food is scarce, has an advantage. As with the long-sighted Bushman so with the long-tongued giraffe, descendants wholly or partially inheriting the variation will form a prosperous and increasing stirp. But now observe that besides extraordinary variations there are the ordinary variations—variations such as those occurring in the sizes of the hands among ourselves. Let us suppose the average length of the giraffe's tongue to be one foot, and that there are all degrees of greater lengths up to thirteen inches, and all degrees of smaller lengths down to eleven inches: the numbers above and below the average being assumed equal. In the prehension of the highest branchlets a number of the shorter-

tongued will fail where a number of the longer-tongued succeed. As every creature multiplies up to the limits set by the means of subsistence, herds of giraffes must be from time to time underfed. At such times the short-tongued ones must be more underfed than the long-tongued ones. The difference of feeding may not be such as to produce in a direct way greater mortality in the one class than in the other, but it may readily tell indirectly. Especially will there be more deaths of the weaker adults, and the less vigorous young they have produced, when the herd is chased by carnivores. Those which are a yard or two behind the rest lose their lives; and a very small defect in the constitutional state of the adults, or the strength of the young, may entail the slight difference in speed implied. So that, other things equal, more of the short-tongued and their offspring will die than of the long-tongued and their offspring. Hence, without any special choice of mates, it will result that in the next generation the average of length of tongue will be greater. Through subsequent generations the same process will go on increasing this advantageous variation, until some limit is reached at which disadvantages check it, or at which the life-sustaining advantages from some other variation become greater.

So that in the absence of any such improbable events as those Lord Salisbury supposes to be necessary, there are two co-operating ways in which survival of the fittest establishes in a species a useful modification of structure.

The great length of time required for the production of species by the evolutionary process, is supposed by Lord Salisbury to furnish a reason for disbelief. In support of his argument he cites Lord Kelvin's conclusion that life can not have existed on the Earth more than a hundred millions of years. Respecting Lord Kelvin's estimate it may be remarked that the truth of a conclusion depends primarily on the character of the premises; that mathematical processes do not furnish much aid in the choice of premises; that no mathematical genius, however transcendent, can evolve true conclusions out of premises that are either incorrect or incomplete; and that while putting absolute faith in Lord's Kelvin's reasonings, it is possible to doubt the data with which he sets out. Suppressing criticism, however, let us accept in full the hundred million years, and see what comes of it. Lord Salisbury argues:—

"If we think of that vast distance over which Darwin conducts us, from the jelly-fish lying on the primeval beach to man as we know him now; if we reflect that the prodigious change requisite to transform one into the other is made up of a chain of generations, each advancing by a minute variation from the form of its predecessor, and if we further reflect that

these successive changes are so minute that in the course of our historical period—say three thousand years—this progressive variation has not advanced by a single step perceptible to our eyes, in respect to man or the animals and plants with which man is familiar, we shall admit that for a chain of change so vast, of which the smallest link is longer than our recorded history, the biologists are making no extravagant claim when they demand at least many hundred million years for the accomplishment of the stupendous process."

I will not stop to criticise the assumption that the jelly-fish is a remote ancestor of man; but, accepting all his data, will simply inquire how far Lord Salisbury's conclusion is warranted by them. As introductory to the criticism, I can not do better than quote another passage from the early essay named at the outset: merely remarking that the physiologist referred to as adverse in 1852, would not be thus referred to now. After remarking that those who know nothing of the science of life may naturally "think the hypothesis that all races of beings, man inclusive, may in process of time have been evolved from the simplest monad, a ludicrous one," the passage continues:—

"But for the physiologist, who knows that every individual being *is* so evolved—who knows, further, that in their earliest condition the germs of all plants and animals whatever are so similar, "that there is no appreciable distinction amongst them, which would enable it to be determined whether a particular molecule is the germ of a Conferva or of an Oak, of a Zoophyte or of a Man"; *—for him to make a difficulty of the matter is inexcusable. Surely if a single cell may, when subjected to certain influences, become a man in the space of twenty years; there is nothing absurd in the hypothesis that under certain other influences, a cell may, in the course of millions of years, give origin to the human race."

Suppose we pursue the comparison indicated in the last sentence. Lord Salisbury invites us to reflect on "the prodigious change" required to transform his hypothetical jelly-fish into a man. He appears never to have reflected upon "the prodigious change" which in a few months transforms the human ovum into an infant. The contrast in structure may not be absolutely as great, since, in the course of the change from infancy to maturity, there is not only increase of size but some increase of structural development. In their essentials, however, the two organizations are alike: differences of proportion and finish chiefly distinguishing them. Let us, then, compare the embryological changes with the evolutionary changes, in their amounts and in the times taken by them. The nine months of human gestation, more exactly stated, is 280 days, that is 6,720 hours or 403,200 minutes. Thus, then, the total change from the nucleated cell constituting the human ovum to the developed structure of the infant just born, is

* Carpenter, Principles of Comparative Physiology, p. 474.

divisible into 403,200 changes each occupying a minute. No one of these changes is appreciable by the naked eye, or even by a micrometer. Turn now to the other member of the comparison. Let us suppose the total change between the primitive *Protozoon*, or nucleated cell, and the human being proceeding from it, to be divided into increments of change, equal in their number to those gone through by the fœtus. To compare the two sets of changes we divide 100,000,000 years by 403,200. What is the result? We get nearly 250 years as the interval available for an amount of change equal to that which the fœtus undergoes in a minute. Another way of presenting the facts yields results still more striking. Many creatures of superior types take more than a year to reach the reproductive age, and even among insects there are some which retain their larval forms for a longer period. But, bearing in mind that even among the *Vertebrata* the immense majority of species reach the reproductive age in a year, while some of them, as the inferior Rodents, reproduce in a shorter term, and remembering that throughout the lower divisions of the undetermined phylogenetic series preceding the vertebrates, consisting of relatively small and simple creatures, the succession of generations was probably more rapid, we may fitly, contemplating the whole series, take a year as the equivalent for a generation. If so, it follows that to achieve the transformation of the *Protozoon* into Man, it requires only that in the space of 250 generations the change shall be as great as that which the human fœtus undergoes in a minute; or, otherwise stating the fact, it requires that each generation shall differ from the last by as much as the fœtus differs from itself after an interval of a fourth of a second.

Should it be urged that the successive stages of the transformation gone through by the infant do not represent fully the stages of transformation gone through in progressing from the primitive nucleated cell to the human being, but that there have been periods of excursive modification on various sides of the direct line, and periods in which there was no advance, or in which there was even some retrogression, it would still result that if, in one generation, there occurred as much change of form as the fœtus undergoes in a minute, the remaining 240 odd generations might be set aside for non-progressive changes: a sufficiently wide margin.

One more misconception embodied in Lord Salisbury's address remains to be noted—not a misconception peculiar to himself, but one which men at large entertain. Speaking of the groups of chemical elements, he says:—

"The discovery of these co-ordinate families dimly points to some iden-

tical origin, without suggesting the method of their genesis or the nature of their common parentage. If they were organic beings all our difficulties would be solved by muttering the comfortable word 'evolution'—one of those indefinite words from time to time vouchsafed to humanity, which have the gift of alleviating so many perplexities and masking so many gaps in our knowledge. But the families of elementary atoms do not breed; and we can not therefore ascribe their ordered difference to accidental variations perpetuated by heredity under the influence of natural selection."

This passage obliges us to infer that Lord Salisbury supposes the theory of evolution to be concerned only with things that "breed." If the molecules of matter were "organic beings," he says, "the comfortable word 'evolution'" might be thought to suggest a solution; but since they are not organic beings, evolution has no place. Apparently, then, Lord Salisbury thinks evolution is concerned only with animals and plants. It is difficult to believe that, well acquainted as he is with the science of the day, he really means that which his words imply. We seem almost bound to assume an inadvertence of expression or a lapse of thought. Still as his statement and his apparent belief have been put before a million or two of readers, it seems needful to do something toward dissipating the misapprehension caused, by briefly indicating what is meant by evolution as rightly understood.

The Cosmos as a whole and in all its parts has reached its present state either supernaturally or naturally; and if naturally then not living things only but all other things have come naturally to be what they are. A doctrine which alleges evolution for the animate world and assumes creation of the inanimate world is absurd. Evolution, if alleged at all, must be alleged as coextensive with all existence—save that which is undergoing the reverse process of dissolution.

One who sees that our interpretations must leave us for ever ignorant concerning the data of the process—the space and the time, the matter and the motion, as well as the ultimate energy manifested through them—may yet rationally seek a proximate interpretation. If things of all kinds, inorganic, organic, and superorganic, have become what they are, not supernaturally but naturally, the implication is that their present state is the outcome of preceding states; and that the genesis of changes throughout the past has been of like nature with the genesis of changes at present. What, then, is the most dominant trait common to successions of changes?

A thing ever being modified and re-modified diverges more and more from its original condition: accumulated changes produce transformation. What is the general nature of that progressive transformation which constitutes evolution? The first

answer to this question was suggested on observing the changes passed through by every unfolding plant and animal. Immeasurably as do the multitudinous kinds of organisms differ from one another, yet the unfoldings of them proceed in similar ways. The detailed changes gone through are infinitely varied, but the general change is the same for all. It has since become apparent that the abstract formula expressing this transformation in all living things, also expresses the transformation which is, and has been, in progress everywhere. The Solar System, in passing from its primitive state to its present state, has exemplified it; and, if we accept Lord Kelvin's conclusion respecting the dissipation of its energy and consequent ultimate fate, it will continue to exemplify it. The transformation of the Earth from those early stages in which its surface began to solidify, down to its present stage, has likewise conformed to the general law. Among living things it is conformed to not only in the unfolding of every organism, but also, if we draw the conclusion pointed to above, by the organic world in general, considered as an aggregate of species. The phenomena of mind, in rising from its lowest forms in inferior creatures up to its form in Man, and again in rising from the lowest human form to the highest, illustrate it. It is again illustrated by the successive stages of social progress, beginning with groups of savages and ending with civilized nations. And we see it no less displayed in all the products of social life—in language, in the industrial arts, in the development of literature, in the genesis of science.

Is this inductive generalization capable of deductive verification? Does this uniformity of process result from uniformity of cause? The answer is—Yes. As the changes universally in progress now and through all past time have resulted in transformations having certain common traits, so also, in the actions everywhere producing them, there are certain common traits. However vast or however minute, every aggregate is like every other aggregate in being subject to the actions of outer things and in having parts that act on one another. Be it the Solar System, which by its motion through space shows that the Stellar Universe around influences it, and which shows that its component bodies influence one another, or be it an infusorium exposed to currents and to living things in the surrounding water, and made up of interdependent organs, we are equally shown that external incident forces affect everything, and that everything is affected by the mutual actions of its parts. But if there is a fundamental unity in the relations of aggregates to their environments and of their components to one another, there must also be a fundamental unity in the processes of change set up in all cases. Hence, then, a certain community of character in the

transformations gradually produced. The empirical generalization indicated above as reached by contemplation of phenomena of various orders, becomes a rational generalization on finding that throughout these various orders of phenomena a like cooperation of causes inevitably works out similar observed effects. It is not by accident but by necessity that these transformations of all kinds have common traits.

This is not the place in which to explain and illustrate this universal law of transformation and these universal causes of transformation. Here I am concerned merely to indicate their scope, and to say that the Doctrine of Evolution, rightly conceived, has for its subject-matter not the changes exhibited by the organic world only, but also the changes which went on during an enormous period before life began, and the changes which have gone on since life rose to its highest form, and Man, passing into the associated state, gave origin to the endlessly varied products of social life. It has for its subject-matter the entire cosmic process, from nebular condensation down to the development of picture-records into written language, or the formation of local dialects; and its general result is to show that all the minor transformations in their infinite varieties are parts of the one vast transformation, and display throughout the same law and cause—that the Infinite and Eternal Energy has manifested itself everywhere and always in modes ever unlike in results but ever like in principle.

How utterly different the popular conception of evolution is from evolution as rightly conceived will now be manifest. The prevailing belief is doubly erroneous—contains an error within an error. The theory of natural selection is wrongly supposed to be identical with the theory of organic evolution; and the theory of organic evolution is wrongly supposed to be identical with the theory of evolution at large. In current thought the entire transformation is included in one part of it, and that part of it is included in one of its factors. From his place of vantage Lord Salisbury might have done much to dissipate these delusions; but, unhappily, both his language and his arguments have tended to do the reverse.—*Nineteenth Century.*

SIR JOSEPH LISTER has been chosen president for the Liverpool meeting of the British Association, to be held in 1896, beginning September 16th. The meeting for 1897 was appointed to be held in Toronto.

PROF. WEISMANN proposes germinal selection as the name of a hypothesis supplementary to that of natural selection, by which he explains an apparent protection of useful variations from their first appearance, so that when wanted for natural selection they are always at hand.

EXPIRED AIR AND PROBLEMS OF VENTILATION.

THE following are substantially the conclusions reached by Drs. J. S. Billings, S. Weir Mitchell, and D. H. Bergey regarding the composition of expired air and its effects upon animal life, which are published in the Smithsonian Contributions. These contradictions of certain accepted views are important and likely to give rise to discussion.

There is no peculiar organic matter which is poisonous to animals (excluding man) in the air expired by healthy mice, sparrows, rabbits, guinea-pigs, or men. The injurious effects of such air appeared to be due entirely to the diminution of oxygen or the increase of carbonic acid, or to a combination of these two factors. It is very improbable that the minute quantity of organic matter contained in the air expired from human lungs has any deleterious influence upon men who inhale it in ordinary rooms. In ordinary quiet respiration no bacteria are contained in the expired air. In the act of coughing or sneezing such organisms may be thrown out. The minute quantity of ammonia, or of combined nitrogen, or other oxidizable matters found in the condensed moisture of human breath appears to be largely due to products of the decomposition of organic matter which is constantly going on in the mouth and pharynx. The air in an inhabited room, such as a hospital ward, in which experiments were made, is contaminated from many sources besides the expired air of the occupants, and the most important of these contaminations are in the form of minute particles or dusts. The experiments on the air of the hospital ward showed that in this dust there were micro-organisms, including some of the bacteria which produce inflammation and suppuration, and it is probable that these were the only really dangerous elements in this air. The results of experiments, in which animals were compelled to breathe air vitiated by the products of either their own respiration or by those of other animals, make it improbable that there is any peculiar volatile poisonous matter in the air expired by healthy men and animals other than carbonic acid. The effects of reduction of oxygen and increase of carbonic acid, to a certain degree, appear to be the same in artificial mixtures of these gases as in air in which the change in their proportions has been produced by respiration. An excessively high or low temperature has a decided effect upon the production of asphyxia by diminution of oxygen and increase of carbonic acid. At high temperatures the respiratory centers are affected, where evaporation from the skin and mucous surfaces is checked by the air being saturated with moisture; at low temperatures the consumption of oxygen

increases and the demand for it becomes more urgent. The proportion of increase of carbonic acid and of diminution of oxygen which has been found to exist in badly ventilated churches, schools, theaters, or barracks is not sufficiently great to account for the discomfort which such conditions produce in many persons, and there is no evidence to show that such an amount of change in the normal proportion of these gases has any influence upon the increase of death-rates which statistical evidence has shown to exist among persons living in crowded and unventilated rooms. It has been well established by observation and statistics that tuberculosis and pneumonia are the diseases most prevalent among persons living and working in unventilated rooms. But consumption and pneumonia are caused by specific bacteria, which for the most part gain access to the air passages by adhering to particles of dust which are inhaled, and it is probable that the greater liability to these diseases of persons living in crowded and unventilated rooms is to a large extent due to the special liability of such rooms to become infected with the germs of these diseases.

The discomfort produced by crowded, ill-ventilated rooms in persons not accustomed to them is not due to the excess of carbonic acid, nor to bacteria, nor in most cases to dusts of any kind. The two great causes of such discomfort, though not the only ones, are excessive temperature and unpleasant odors. The cause of the unpleasant, musty odor which is perceptible to most persons on passing from the outer air into a crowded, unventilated room is unknown; it may, in part, be due to volatile products of decomposition contained in the expired air of persons having decayed teeth, foul mouths, or certain disorders of the digestive apparatus, and it is due in part to volatile fatty acids given off with, or produced from, the excretions of the skin. The results of this investigation, taken in connection with the results of other recent researches, indicate that some of the theories upon which modern systems of ventilation are based are either without foundation or doubtful, and that the problem of securing comfort and health in inhabited rooms requires the consideration of the best methods of preventing or disposing of dusts of various kinds, of properly regulating temperature and moisture, and of preventing the entrance of poisonous gases, like carbonic oxide derived from heating and lighting apparatus, rather than upon simply diluting the air to a certain standard of proportion of carbonic acid present.

It would be unwise, however, to conclude from the facts given in this report that the standards of air supply for the ventilation of inhabited rooms, which are based on the results of Pettenkofer's work, are too large.

Editor's Table.

THE ECCLESIASTICAL VIEW OF EDUCATION.

OUR attention has been drawn to an article by an excellent contributor of our own, Dean Carmichael, of Montreal, which appeared a few months ago in the Canada Educational Monthly, on the subject of "Religion and Education." The writer is candid, able, and eminently well-meaning, but we find it impossible, nevertheless, to agree with the views he puts forth, or at least with his main contention.

The dean is much impressed with the rapid progress which education has been making in the modern world, and he prophesies that, if the same rate of progress is maintained for seventy-five or a hundred years longer, it will be impossible in any civilized country to gather together so ignorant a crowd as that which tore down the Bastile in 1789. Does that mean that society will then be safe from such convulsions as marked the French Revolution? By no means: crowds may again gather for deadly work, but they will be educated crowds, each man able to write his name and read his paper and proceed with the business of destruction "as an intelligent being, instead of being whirled to it as an atom in a vortex." The dean sees signs of great disturbance in the present day, and he thinks that education, as it is now being imparted to the masses, is rendering society not more but less stable. "The millions," he says, "that in times past were only used to dig and delve, to fill up giant armies, to crowd pauper workhouses, to tenant penal settlements," are being reached by the light of education and are "fast growing into mental as well as physical power." One would be disposed to think that this was not a very lamentable prospect, but it fills Dean Carmichael's mind with the gravest apprehensions. Why? Because he does not see how the minority are going to hold this vast educated majority in check. That the majority must be held in check, unless society is to go to smash, he seems to consider axiomatic. The specific complaint he makes against modern education is that it is virtually divorced from religion. "The whole tide," he says, "of modern civilization, as set going and lauded by the middle and higher classes of society, desires either to sweep distinctive religious teaching clean out of the world's curriculum, or to put it into a corner with a fool's cap on its head. . . . No greater anomaly, I think, has ever existed than that of institutions based upon the open principle that the Bible is the foundation of all education, practically joining hands with unbelievers the world over to make the Bible the least prominent volume of instruction in public education."

These quotations at once indicate the writer's standpoint and suggest our reply. The "anomaly" which appears so striking and inexplicable in his eyes loses much of its extraordinary character on close examination. The question is this: Why are Christian parents so generally willing, where they are not actually desirous, that the Bible should not be made an authoritative text-book in the public schools? Many reasons may be assigned. In the first place, they know that the Bible as it stands, in its entirety, is not adapted

to be a school-book. A school-book, as the term is now and has always been understood, is one specially prepared for the uses and needs of the school, and containing nothing that is not required for purposes of instruction. This is not the case with the Bible, which was not written or put together with any such view, and much the larger part of which is quite unsuited to school use. In the second place, parents know that the Bible is not a book which the first comer can interpret; certainly they are not prepared that the first comer should interpret it to their children. In large part it is a repertory of mysteries which the ordinary certificated teacher has no recognized fitness for handling. If we take even those teachings of the sacred volume which might be considered of the greatest practical importance for purposes of moral instruction, we find that they are far from being viewed in the same light by all professedly Christian parents. Take, for example, the subject of future punishment: the views which one parent might think salutary another would exceedingly object to having placed before his child. We know of a case in which a clergyman of Dean Carmichael's communion was called in to visit a dying man who had previously been visited by a Methodist minister. He found the man's mind greatly disturbed by what the Methodist had told him of the nature of sin and the necessity of conversion, and had much difficulty in relieving him from the excessive fears—excessive from *his* point of view—which this teaching had awakened. Finally, he told the man that what the Methodist had said was all stuff, and that, if he was sorry for his sins, that was enough; he need have no anxiety. We mention this to illustrate the radically different views which different sects hold, not on minor but on major and most practical questions of biblical doctrine. If on these there are divergent views, what anomaly is there in the general disposition of Christian parents to acquiesce in the disuse of the Bible as a public-school text-book, and to look for its proper interpretation and application to their own chosen and specially-trained spiritual pastors?

But these are not the only reasons. The fact can not be ignored that there is much in the Bible which, from a scientific and historical point of view, does not harmonize with the general character of modern education. Take the several branches of so-called "secular education," and we find that each bears in the strongest manner the impress of the "positive" spirit. If there is any idea that is excluded more rigorously than any other from the whole compass of ordinary scholastic studies it is the idea of the supernatural. No secular history would be read in our schools to-day, or in the schools of any enlightened community, in which the fortunes of nations were represented as controlled by special divine intervention. The time has passed when plagues, earthquakes, and famines could be historically interpreted as expressions of divine displeasure; and the time has almost passed for any useful introduction of the doctrine of design in connection with the study of Nature. The spirit of the inductive philosophy has penetrated everywhere: we should not seek in vain for its signs even in the kindergarten. How, then, we are compelled to ask, can the Bible, which deals in miracle from the first page to the last, be employed as a regular text-book in the schools without either suffering in its influence from the prevalent tone of the other school studies, or marring more or less the effect of those studies by its constant championship of the

supernatural idea? It may be said that so long as the Bible is read and expounded and treated as authoritative in the churches, the same conflict between naturalism outside the Church and supernaturalism within it will exist; but to this may be answered that on the clergy rests the responsibility for finding a *modus vivendi* between the two, and that, with their special learning and the special interest they have in the matter, much may be possible to them that is wholly beyond the scope of the lay teacher in a public school. There are clergymen who tell us to-day that it is in no wise necessary to believe in the biblical story of creation as a record of facts, and some are almost prepared to dispense with all belief in the miraculous; but could the school teacher in whose hands the Bible was placed as an authoritative text-book be allowed or expected to indulge in such critical exercitations? The idea is ridiculous: a text-book is a text-book, and its meaning must lie on the surface; its words must be susceptible of being taken at their face value; and no special gifts or graces must be required for its satisfactory use as a text-book.

That the Bible as a whole is a most impressive book; that it bears a noble stamp of earnestness and moral elevation; that it contains moral teaching of inestimable value —these are propositions which we should be the last to deny; but, admitting them to the full, we still consider that it is a wise and true instinct which reconciles the majority even of those who place the highest estimate on the Bible to dispensing with its use in the public schools.

But how about those masses who, according to Dean Carmichael, are becoming educated, and owing to that very fact more dangerous than the mob that stormed the Bastile? That all the signs of the times are favorable we by no means think; but as regards the influence of popular education, what we dread is not the awakening of the intellect of the multitude so much as the stifling of it and the enslaving of it to false ideas. So far as popular education has an awakening effect, its influence, we doubt not, will be good. A man does not become dangerous because he has learned to sign his name; but he becomes dangerous both to himself and to others if he has been taught to dissociate cause and effect; if he has got it into his head that benefits may be obtained without labor; if his brain has been muddled with the notion that others are responsible for making him happy and prosperous. We dread an education which in any way withdraws a youth from the salutary influence of natural reactions and tends to give him an artificial conception of the world he lives in. We dread an education which favors the formation of indolent habits, or which confuses and enfeebles the mind by calling upon it to pursue abstract trains of thought when it should be occupied with the concrete. We dread an education which at once excites ambition and disinclines for toil; which gives a smattering of many things, but no true sense of power or competence in regard to anything; which represses individuality and so robs character of a main element of strength. And all these unfavorable results, we fear, are wrought by much of the education that is imparted to-day. But to try to conquer our evils or avert our perils by driving back the masses into ecclesiastical penfolds is as chimerical an idea as could well be conceived. The world is willing, and more than willing, to listen to those who can shed a glory upon human life borrowed from regions of faith and hope that lie above our ordinary range of

thought; but it is not willing, and never henceforth will be willing, to substitute any form of theological prescription for the authority which it has learned to attach to verified truth. If we have battles to fight we must fight them, and perhaps, when it comes to that, we may learn a wisdom which in times of comparative ease and prosperity we were incapable of learning. Certain it is that in this world everything has its specific cause, which means that every evil has its specific remedy. Trouble, it was long ago observed, does not spring out of the ground; it is for us to find out where it does spring from; and when the trouble becomes acute, our intellectual operations are wont to be greatly stimulated.

The dean would have us restore the Bible to the schools and place the latter in effect under the control of the clergy. Our idea is to study out the problem of education in the widest sense until we have, in a really effectual manner, correlated it with the whole life of society. The former is the ecclesiastical remedy for social ills; the latter is the scientific, and we believe it to be that which the future is destined to justify.

THE HUNDREDTH ANNIVERSARY OF THE FRENCH INSTITUTE.

THE Institut de France, popularly known as the French Academy, and which is undoubtedly the oldest and the most famous of the world's learned societies, celebrated with great ceremony and with the active participation of the Government of France, on October 23d–26th last, the hundredth anniversary of its existence; one of the most noted and pleasant features of which was the hearty welcome extended to its foreign associates and corresponding members. As it is generally understood that these two titles are the highest honors which France can award in testimony of intellectual work actually done by foreigners—the cross of the Legion of Honor being often conferred for merely political reasons—it is a matter of interest to know what citizens of the United States have been the recipients of these honors. Preliminary, however, to their specification, it is desirable to explain the organization of the institute. It consists of five departments or divisions, each of which is designated as an academy—namely, the Académie Française, Académie des Inscriptions et Belles-Lettres, Académie des Sciences, Académie des Beaux-Arts, Académie des Sciences Morales et Politique. Each academy, except the Académie Française, which comprises a general reunion of all the other academies, is divided into sections for the consideration of special subjects, and is made up of members of the institute who are regarded as specialists, or acknowledged authorities in different departments of learning. Thus, the domain of the "Académie des Inscriptions et Belles-Lettres" embraces the learned languages, antiquities, monuments, Oriental literature, and history; that of "Sciences," astronomy, geography, navigation, general physics, chemistry, zoölogy, botany, medicine, and surgery; that of "Beaux-Arts," painting, sculpture, architecture, engraving, and music; and that of "Sciences Morales et Politique," morals, philosophy, jurisprudence, political economy, finance, and philosophical history. Each of the academies holds weekly meetings, and once a year the five academies as a rule hold a public meeting in common; and occasionally other general meetings for the reception of new members and the distribution of prizes. In virtue of endowments, be-

quests, and the like, the institute is in receipt of annual revenue of at least five million francs ($100,000), which it distributes annually in the form of prizes for merit in respect to literary work, inventions, scientific discoveries or researches, and also for examples of what are termed "impecunious" virtue.

The institute, comprising the above five academies, is primarily composed of forty members, who by rule or custom are always and exclusively natives of France, and who, on the assumption that their achievements in the various departments of learning have assured to them permanent reputation, are popularly designated as the *Immortels*. Each one of these receives an annual life salary from the state of twelve hundred francs, and a small additional sum contingent on personal attendance at the regular meetings of the academies and Institute.

Besides the primary or permanent members, the institute is made up of two other classes of members—namely, *Associés Étrangers* (foreign associates) and *Correspondants*. The number of the former is limited to thirty-two persons of foreign birth and residence, and comprises such names as Gladstone, Alma Tadema, Sir Frederick Leighton, President of the British Royal Academy, Max Müller, Sir William Thomson (Lord Kelvin), Sir John Millais, and Verdi, the Italian composer. Of the names of members of this class deceased within a comparatively recent period may be mentioned those of Agassiz, Helmholtz, De Candolle, Richard Owen, Curtius, the German historian, and Bunsen and Wohler, the celebrated German chemists. As yet the name of no citizen of the United States has been inscribed on the roll of the foreign associates of the institute, although it is understood that in a recent election to fill the vacancy occasioned by the death of a member, the name of Prof. Simon Newcomb, of Washington, lacked but a few votes of receiving this honor.

Next in order in the organization of the institute is the class of corresponding members, an election to which, irrespective of nationality, is regarded as a very high honor, though not as great as a membership among the thirty-two foreign associates. The number of correspondents reported in the *Annuaire* of the institute for 1893 was two hundred and fifty-six, about one third of whom were French citizens. The following list exhibits the names and the date of the election of the correspondents, including those recently deceased, who have been elected from the United States:

Prof. James D. Dana, zoölogist, New Haven, Conn., 1873, deceased; David A. Wells, economist, Norwich, Conn., 1874, elected to fill the vacancy occasioned by the death of John Stuart Mill; Prof. Simon Newcomb, astronomer, Washington, D. C., 1874; Prof. William Whitney, linguist, New Haven, 1877, deceased; George Bancroft, historian, 1877, deceased; Asaph Hall, astronomer, Washington, D. C., 1879; Benjamin Apthorpe Gould, astronomer, Cambridge, Mass., 1881; Richard Morris Hunt, artist, 1882, deceased; James Hall, geologist, Albany, N. Y., 1884; Alexander Agassiz, naturalist, Cambridge, Mass., 1887; Prof. Samuel Langley, Superintendent Smithsonian Institution, astronomer, 1888—seven living members, none of whom were present at the centennial celebration. Among some of the present or recent correspondents from countries other than France and the United States may be mentioned the names of Momsen, the distinguished German historian; Struve, the Russian astronomer; Lockyer, Huggins,

Huxley, Burne-Jones, Bryce, Fitzjames Stephen, Goschen, Sir John Hooker, England; Nordenskiold, Sweden; Vogt, Switzerland; Virchow, Roscher, Germany; Lanciani, Rome; Jacoby, Austria, etc.

The Institute of France is not as important an organization as it was fifty years ago, but it is still influential through its elections, which are regarded as acknowledgment of scientific merit, and the prizes it annually awards for original research, discoveries, and inventions. It maintains its authority not upon its prestige in the past, but upon the fact that it always enrolls among its members the most distinguished scientists and writers of France, and such citizens of other countries as have in its judgment done great and original work in any department of human knowledge. In the opinion of one of its most distinguished living members, M. Berthelot, the noted French chemist, and present (1895) French Minister of Foreign Affairs, the Academy of Sciences, "if it no longer has the initiative of discoveries, it at least constitutes a dike against charlatanism, and aids in giving the widest publicity to the achievements of French and foreign *savants*."

Scientific Literature.

SPECIAL BOOKS.

THE world is always conscious of an addition to its intellectual wealth when a leader in original scientific work writes a book. Men like to hear from the masters, especially when they speak, as Prof. Young does, a language that inspires while it instructs.* When the first edition of this uniquely interesting book was put forth in 1881 a warm welcome awaited it, not only from astronomers who were eager to learn what one of the foremost investigators of solar phenomena had to say about the sun, but from all readers who take pleasure in seeing the literary powers of our mother tongue turned to useful account in the presentation of the facts of science. And the welcome grew as the circle of the book's readers rapidly widened. No volume of the International Scientific Series has proved more continuously popular.

But the fourteen years that have elapsed since the first appearance of Prof. Young's book have witnessed remarkable advances in astronomy, and particularly with regard to our knowledge of the sun. For a time it was possible to keep the book up to date by notes and appendices to its successive editions. At length this method of revision no longer sufficed, and the author undertook a thorough rehandling of the work, involving the rewriting of considerable portions, and the addition in the text of much that was needed "to make the book fairly representative of the solar science of to-day." That in its revised form it now answers the above definition, quoted from the author's new preface, no one who knows Prof. Young's habitual caution and precision of statement will doubt.

No authoritative utterance concerning a progressive branch of science

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* The Sun. By Charles A. Young, Ph. D., LL. D., Professor of Astronomy in Princeton University. New and revised edition. Pp. 363, 12mo. New York: D. Appleton & Co. Price, $2.

ever came more opportunely than this new edition of The Sun. Within the past few years discovery has followed discovery, and theory has obscured theory in solar physics so rapidly that the general reader, desirous to keep on safe ground, has found himself in a more or less uncomfortable position. One authority, of great weight, has been telling him that the "faculæ" and the "prominences" are identical phenomena; another authority, of perhaps equal weight, has assured him that this is not so. Likewise, in regard to the most interesting question of the connection of sun spots with terrestrial magnetism: on the one hand stand positive assertions of an intimate relationship of that kind, and on the other hand stands Lord Kelvin with his dictum—and the dicta of Kelvin in science have frequently been deemed of equal weight to those of Lord Coke in law—asserting that "we may be forced to conclude that the supposed connection between magnetic storms and sun spots is unreal, and that the seeming agreement between the periods has been a mere coincidence."

Then there have been new theories of sun-spots, new determinations of the solar parallax, new identifications of elements in the sun, the wonderful work of Langley on the infra-red portion of the spectrum, the questions raised by Lockyer's theory of the "dissociation" of elements in the sun, the question of the existence of oxygen in the solar atmosphere, the question whether the sun-spots are really depressions, and many other new and puzzling things, the most surprising of all being, perhaps, the discovery in a Norwegian mineral of "helium," an element which had been found in the sun as long ago as 1868, but the presence of which on the earth had never been detected.

Amid such a confusion the unprofessional wayfarer in science needs a guiding hand, and that is what Prof. Young now most seasonably offers. There is a fairness, a power of discrimination, and a judicial balance in our author's treatment of vexed questions that must create in the reader's mind both confidence and admiration. His brief, shrewd reply to the remark of Lord Kelvin, quoted above, concerning sun-spots and magnetic storms, will find many highly interested readers, and it is made all the more attractive by the vista of possible future discovery which it opens with the suggestion that "it is not perhaps outside the limits of possibility that both the solar and terrestrial disturbance have a common origin in some invasion of power or matter from outer space—that the solar tumult is the brother, and not the father, of our own aurora."

Prof. Young's discussion of Helium, its Identification and Properties, is, of course, luminous and informing in the highest degree. Nothing can be more pleasing than to note the manner in which an unexpected discovery, full of momentous consequences for the work with which he is identified, is received, assimilated, and irradiated by the mind of a leader in science.

Among the new matters treated, one of the most interesting, because it relates to hoped-for advances in the future, is the effort to render the corona visible when the sun is not eclipsed. It is certainly encouraging to know that to Prof. Young "the case appears by no means absolutely hopeless." When we remember the advance in our knowledge of the prominences following Janssen's and Lockyer's discovery in 1868, that those phenomena could be rendered visible with the spectroscope in ordinary daylight, and consider the ignorance that probably would have prevailed

concerning them if they had remained unseen except during eclipses, we can echo our author's opinion that success in revealing the mysterious corona in a similar manner "is certainly devoutly to be desired."

Prof. Young has so long been a conspicuous and brilliant figure in the field of spectroscopic investigation that one naturally turns to his revised chapter on The Spectroscope and the Solar Spectrum with pleasing anticipations which are not disappointed. The results of the immense work accomplished in the last decade are here ranged in order with an expert hand, and the remaining gaps in the line of acquired knowledge are made clearly apparent. The list of elements known to exist in the sun has been largely extended in the past few years, but still many that go to constitute a great portion of the crust of the earth have not been recognized in the solar spectrum. Why are they absent? Is it simply a failure to show themselves, or do they not exist there at all? Prof. Young indicates his preference for the view that the missing elements are not really absent from the sun, but only nonapparent, although he points out that the answer to the question is not easy. And then he goes on to marshal some most interesting facts and considerations relative to this subject, and discusses briefly but luminously such topics as the multiple spectra of certain elements, Lockyer's revival of the old "pantogen" speculation and his theory of "basic lines" common to the spectra of different substances, the later work on the question of solar oxygen, etc.

While this book is a record of facts and achievements rather than of theories and attempts at the interpretation of mysteries, yet the great questions still remaining to be answered are, of course, discussed, and in a masterly manner. A fine instance of the author's method of dealing with such subjects is shown in the chapter on The Sun's Light and Heat, where he succinctly reviews questions like these: "How is the sun's heat maintained?" "How long has it lasted already?" "How long will it continue?" "Are there any signs of either increase or diminution?" It is undoubtedly true, as Prof. Young remarks, that to such questions, "in the present state of science, only somewhat vague and unsatisfactory replies are possible," yet they are questions the replies to which, however incomplete, will always command deep interest. And if the facts and speculations accumulated since 1881 have not thrown much light upon these subjects, something has been gained in a clearer comprehension of both the strength and the weakness of prevailing theories. Those are pregnant sentences, for instance, in which, after pointing out the objections to the late Dr. Siemens's theory of the sun, he remarks: "And yet one almost regrets that the theory can not be accepted, for it would remove very serious difficulties that now embarrass the problem of the evolution of our planetary system. The accepted contraction theory of Helmholtz certainly appears to allow too little time for the sun's lifetime of radiant activity to be consistent with a reasonable explanation of the process by which the present state of things has come about."

In briefly summarizing the principal additions noted in the new edition the following may be particularly mentioned: The latest work on the solar parallax, including Newcomb's results and the observations on the minor planets Victoria and Sappho; accounts of all recent advances and discoveries in solar spectroscopy and spectro-photography, including the work of Hale, Deslandres, Dunér, etc.; a statement of the latest accredited theories

concerning sun spots, such as Schæberle's and Oppolzer's, and an account of Dunér's and the author's work on sun-spot spectra; a summary of recent progress in prominence photography, etc.; facts and conclusions concerning the corona, based on recent eclipses; an account of Langley's infra-red spectrum investigation, and of the work of De Chatelier, Wilson, Gray, and Scheiner on solar radiation and temperature; and, finally, a most interesting supplementary note, already mentioned, on Helium. The size of the volume has been increased by nearly thirty pages, and the number of illustrations has been raised from eighty-two to one hundred.

The Sun, in its new form, certainly deserves, and will unquestionably obtain, an even greater circulation than that which it has hitherto enjoyed.

"Live" natural history is what Prof. *Miall** would lead the young naturalist to. While he has no disparagement for systematic zoölogy, he wishes to revive an interest in the writings of Swammerdam, Réaumur, Lyonnet, and De Geer, and to promote that observation of the structure and habits of living animals which those authors pursued with most profitable results. In so doing, he is only restoring a balance that has been disturbed of late years. It is certainly an attractive field into which our author invites the amateur. Who does not love to follow a stream through its alternations of still deeps and rippling shallows, or to stroll along the shore of the ever-moving sea? Whether one be occupied with sport or science, the movement of the water and the succession of traces of its action upon the land yield no small enhancement of pleasure. Aquatic insects do not form a distinct class. Representatives of eleven orders are described in this book, so that the spice of variety is not wanting in their study. Under the guidance of Prof. Miall one may watch at leisure the swiftly darting whirligig beetle or examine the fine case of instruments of the female gnat (there are no mosquitoes, our author says, in zoölogy). Other insects classed as aquatic, because they pass their larval and pupal stages in water, are drone flies (the oxen-born bees of the ancients), dragon flies, pond-skaters, tube-making caddis-worms, etc.; all are air-breathers in the adult form. A phenomenon which profoundly affects the lives of these creatures is the surface film of water. By curious adaptations they take advantage of its tension, while on the other hand some minute creatures find it a death-trap. The reader must not look for a severely logical arrangement in this book. There is an introduction in which the invasion of the waters by insects, the surface film, live natural history, and other topics are discussed philosophically. Directions for capturing specimens will be found not among the preliminary matter, but on page 114, and there are biographical notes about the old naturalists where the first extended citations from their respective writings occur. In the illustrations sufficient magnifying power has been used to make the organs of the insects readily distinguishable, with the result of giving some of the little creatures a truly formidable appearance.

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* The Natural History of Aquatic Insects. By L. C. Miall, F. R. S. Pp. 395, 12mo. London and New York: Macmillan & Co. Price, 6*s*.; $1.75.

GENERAL NOTICES.

We can hardly conceive a more fascinating subject than the one treated of in this book.* Birds, by their song, their marvelous flight, their mysterious migrations, the independent intelligences among them, which have led in past times to many species becoming the associates of man, offer a most delightful subject for study. It is interesting to recall the fact that Cuvier and his contemporaries regarded the birds as a closed type, a group that seemed completely isolated from the other classes of vertebrates, and now they are known to be closely related to the reptiles. Mr. *Headley* has devoted considerable space in his book to these reptilian affinities. In his chapter on the embryo bird he might have added other reptilian characters, such as the claws which are seen on the fingers on the embryo sea-pigeon; particularly he might have described more fully the tarsal bones, showing that the ascending process of the astragalus had an independent center of ossification, and represented in the embryo the intermedium wedged in between the distal end of the tibia and fibula as shown in the salamanders. Birds may be cited for almost every point defined by Darwin in his theory of natural selection, not only in their reptilian affinities, as shown in their embryological and paleontological history, but in the very remarkable examples of variation in habits, color markings, albinism, molting, sexual selection, protective coloration, etc. The author's ideas of homology and analogy are somewhat obscure. Having correctly defined analogy by the common example of a bird's wing and an insect's wing as being alike in function, but different in origin of structure, and hence analogous and not homologous, he proceeds to say that there is no homology between the wing of a bird and the wing of a bat; whereas there is the strictest homology in origin, structure, and function. In the next sentence he says that the tails of all vertebrates are homologous, which is correct. Yet here we have a few vertebræ in one tail and over fifty in another. We have the broad fin of a fish, the trowel of the beaver, and the climbing appendage of the monkey, and all are indeed homologous. In the same way limbs of the vertebrates are homologous; whether it be the pectoral fin of a fish, the leg of a turtle, the wing of a pterodactyl, of a bird or a bat, or the arm of man, a strict homology runs through them all. Mr. Headley has managed his material admirably, and one gets in a condensed form many facts about birds which have been brought to light within recent years. The clearness of the illustrations gives an added value to the book.

A difficult problem can be solved only by attacking it from one side after another. Prof. *Donaldson* has made his contribution to ascertaining the nature and action of the mind by setting forth the mode of growth of the chief portion of the nervous system.* He introduces his specific subject by three chapters discussing the general phenomena of growth and the rate of increase of the whole body. Then taking up the brain and spinal cord, he presents statistics showing at what rates these organs increase in weight and what weights they attain. He finds that the facts now available "contribute mainly to a healthy skepticism concerning the current interpretations of brain-weight." The author next traces the growth of the nerve elements and describes the architecture of the nervous system, calling attention to the changes of structure that are due to the growth of the organism. The process of dissolution in old age is also traced. Chapters on localization of function, physiological rhythms, and fatigue furnish additional data for the author's discussion of the subject of education, which concludes the volume. From these data he finds that "education must fail to produce any fundamental changes in the nervous organization, but to some extent it can strengthen formed structures by exercise, and in part waken into activity the unorganized remnant of the dormant cells. . . . On neurological grounds, therefore,

* The Structure and Life of Birds. By F. W. Headley, M. A. Pp. 417, with Illustrations. New York: Macmillan & Co. Price, $2.

* The Growth of the Brain. By Henry Herbert Donaldson. The Contemporary Science Series. Pp. 374, 12mo. London: Walter Scott, Ltd. Price, 3*s.* 6*d.* New York: Charles Scribner's Sons. Price, $1.25.

nurture is to be considered of much less importance than Nature, and in that sense the capacities that we most admire in persons worthy of remark are certainly inborn rather than made." From his point of view, therefore, "the formation of habit and reduction of mental friction, by means of concentration, must ever remain the chief objects of a formal training."

Dr. *Parkes's* book,* dealing, in small compass, and in simple language, with the important subject of hygiene, is well suited for use in either the school or the household. The opening chapter, entitled Water, treats of such questions as the proper sources of drinking water, dangers from wells and cisterns, and the filter problem. In the second chapter, on domestic refuse, the sanitary disposal of garbage, dust, etc., is discussed, considerable space being given to sanitary methods of plumbing. Air and ventilation are next taken up, the composition of air, its fouling by respiration, combustion, and organic refuse, cubic space and floor space, introduction of fresh air into rooms, and the practical examination of the ventilation of rooms being some of the important topics. The various methods of heating and lighting are compared in the next two chapters. The open fireplace and the incandescent electric light are selected as the methods which most nearly approach hygienic requirements. When considering the Welsbach lamp the author makes a curious mistake. In speaking of the incandescent mantle, which is composed of the oxide of some of the rarer refractory earths, he calls it the "*asbestos* gauze mantle." How to construct a healthy house—floors, walls, ceilings, cellars, etc.—and the proper site for building occupy Chapters VI and VII. Classification and composition of foods, vegetarianism, cooking, meal times, appetite, infant feeding, condiments, alcohol, tea, coffee, cocoa, and mineral waters are some of the special topics considered in a long chapter devoted to Food. Physical Exercise, Clothing, and The Care of the Skin, Teeth, and Bowels form the last three chapters of the book. The intention has apparently been to make a practical guide for the average householder, and this result has been well attained.

Animal life is coextensive with the earth. The sea swarms with it, the air teems with it. The extreme cold of the arctic regions and the torrid heat of the equator have each their own special forms. The most elementary knowledge of zoölogy is sufficient to show us that, while much of the difference between the faunas of separated islands and continents and even of approximately contiguous regions is due to the differing flora and climatic conditions, these two factors do not in all cases explain the phenomena of distribution. Mr. *Beddard's* book* is a study of animal life in its relation to latitude and longitude. In Chapter I the author treats of the general facts of the distribution of animals. The special regions which have been arranged for the study of zoölogical geography by various authors are dealt with in Chapter II, and Mr. Sclater's chosen as the ones most convenient. In the third chapter the causes which influence the distribution of animals—temperature, means of dispersal, capacity for migration, human interference, large bodies of water, etc.—occupy fifty of the most interesting pages of the book. The fauna of islands and some theoretical considerations, the latter comprising a discussion of the bearing of distribution on origin, the place of origin of the marsupials, and the theory of the polar origin of life, make up the two closing chapters. The book contains five maps, which graphically show the distribution of special forms of animal life.

In order to make the Werner edition of the Encyclopædia more serviceable to its users, *A Guide to Systematic Readings in the Encyclopædia Britannica*, prepared by *James Baldwin*, has been published (Werner Co., $2). The Guide is designed to enable a person to read up a subject thoroughly by directing him to all articles or parts of articles bearing upon it which the Encyclopædia contains. A great cyclopædia is more than a work to be referred to for detached facts. It is a biographical dictionary and a gazet-

* The Elements of Health. By Louis C. Parkes, M. D. Pp 246, 12mo. Philadelphia: P. Blakiston, Son & Co. Price, $1.25.

* A Text-book of Zoögeography. By Frank E. Beddard. Pp. 246, 12mo. London: C. J. Clay & Sons. New York: Macmillan & Co. Price, $1.60.

teer; it contains a history of the world, a treatise on each of the arts, sciences, and professions, a history of every literature, and many other treatises which are frequently issued as separate volumes. Fifty-two text-books now used in colleges consist of articles prepared by their authors for the Britannica. There are three divisions of the Guide. For boys and girls it has home readings in history, biography, science, and on sports and games. For the student it has courses of reading in history, language, literature, the sciences from astronomy to zoölogy, the Bible, etc. In another division it has lists of articles of interest to the merchant, the builder, the electrician, the gardener, the physician, the journalist, the miner, the home-maker, and many others. Many of the references are to the American Additions and Revisions, which the Werner Company has inserted in its edition of the Britannica.

The History of English Literature, by Prof. *W. M. Nevin*, is based on the conception that literature, like history in general, is an organic process or growth. It springs up out of a nation's life and is its proper expression, always modified by its racial tendencies, its degree of civilization, its climate and soil, and its relations with surrounding nations. The book is designed to furnish interesting and useful information to readers generally, as well as to students in particular. It was arranged to meet the needs of the author in lecturing to his classes, and hence ought to be of practical value to the teacher as well as the student. (Intelligencer Printing Office, Lancaster, Pa.)

The financial essays by *Allen Ripley Foote*, collected in the book entitled *A Sound Currency and Banking System* (New York, G. P. Putnam's Sons), were written with the conviction that business panics are ultimately the result of incorrect monetary education finding its expression in unsound legislation. Believing that the immediate return and continued maintenance of a high degree of prosperity for all the people are not prevented by any natural economical condition, the author seeks the appointment of a monetary commission, which, he assumes, acting discreetly, can devise a sound currency and banking system that will remove the cause of financial panics; and the purpose of his essays is to assist in securing the appointment of such a commission and help to a right understanding of the importance, aim, and direction of the work it should do.

While studying the Salishan languages of Washington and Oregon, Dr. *Franz Boas* learned that the dialects of the lower Chinook were on the verge of disappearing, and that some of them were remembered by only a few individuals. This fact determined him to make an effort to collect what little remained of them. With considerable difficulty he found a person who understood the Chinook, was acquainted with its stories, and intelligent enough to communicate them to him. The results of his labors are embodied in a paper on *Chinook Texts*, which is published with the originals and interlineal and current translations of the mythological and other stories, by the United States Bureau of Ethnology.

In the *Spirit of the Papacy*, *J. S. Hittell* examines the papacy in its political, intellectual, and ethical, as distinct from its theological, aspects. He undertakes to show by what devices it has tried to enslave the human race, and to prove that it is now dwarfing the intellects of those Catholics who submit to its control. He says that there are at present two great classes of Catholics—those including the high clergy, who resist everything in the shape of an innovation or advance; and a larger class, who have drawn near to the Protestants, and who plead for greater friendliness between the adherents of the two great branches of the Christian Church. (The author, San Francisco.)

The two great sources of difficulty to the beginner in geometry are the comparative novelty of the subject-matter and the unaccustomed clearness of conception and exactness of expression required in this new study. In *Elements of Geometry*, by *John Macnie*, edited by E. E. White (American Book Co., $1.25), the author says that the second source of difficulty is most easily diminished by reducing the first to a minimum. He has tried to present the subject of geometry with a "logical strictness approaching that of Euclid, while taking advantage of such improvements in arrangement and notation as are suggested by modern experience. . . . The function of a geometry is only secondarily the presenta-

tion of a system of useful knowledge, its greatest value lying in affording the only course in strict reasoning with which the majority of students will become acquainted." With these two beliefs as guides, the author has made an attractive and useful little text-book.

Magnetism: its Potency and Action, is the title of a volume in which *George W. Holley* has recorded some of his observations, experiments, and speculations on the magnetic force (Arena Publishing Company, $1.25). Among the topics that he discusses are the influence of magnetism on animal and vegetable life, the experiments of M. Hertz, "electric girls," spiritual phenomena, thought transference, hypnotism, and the action of the planchette. He sees magnetism manifested in the action of the brain and the heart, in the homing faculty of animals, the transformation of grubs, and various other phenomena. In this volume also the author outlines a new cosmography, which he illustrates by a diagram.

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Fragments of Science.

The Anniversary Meeting of the Royal Society.—The anniversary meeting of the Royal Society was held in its apartments at Burlington House, London, on St. Andrew's Day, Saturday, November 30, 1895. After the delivery of the presidential address by Lord Kelvin, the medals were presented as follows; The Copley medal to Prof. Karl Weierstrass, for Mem. R. S. (received on his behalf by the Foreign Secretary), for his investigations in pure mathematics; a Royal medal to Prof. James Alford Ewing, for his investigations on magnetic induction in iron and other metals; a Royal medal to Dr. John Murray, for his services to biological science and oceanography, in connection with the Challenger reports, and for his original contributions to the same; and the Davy medal to Prof. William Ramsay, for his share in the discovery of argon, and for his discoveries regarding gaseous constituents of terrestrial minerals. The officers elected for the ensuing year are as follows: President, Sir Joseph Lister, Bart.; Treasurer, Sir John Evans; Secretaries, Prof. Michael Foster and Lord Rayleigh; Foreign Secretary, Mr. Edward Frankland. Lord Kelvin closed his address with the following remarks: "I thank you all, my colleagues of the Royal Society, for electing me five times to be your president, for forgiving me all my shortcomings, and for the inestimable benefit which you have conferred on me by giving me your friendship." In the evening the anniversary dinner was held at the Hôtel Métropole, when the newly elected president, Sir Joseph Lister, occupied the chair. The retiring president, in his anniversary address, and several of the speakers at the dinner, dwelt at some length on the great loss which

science and humanity had sustained through the deaths of Huxley and Pasteur.

Pasteur's Successor.—We take the following note from the Practitioner: M. Émile Duclaux, who has just been appointed Director of the Pasteur Institute, in succession to M. Pasteur, was his former chief's oldest collaborator, and had held the post of subdirector under him since the foundation of the institute. He was born at Aurillac in 1840, and was Pasteur's assistant in the École Normale from 1862 to 1865. After teaching for a time in the Tours Lycée in 1865–'66, he was appointed Professor of Chemistry at Clermont in 1866, and afterward of Physics in the Lyons Faculty of Sciences in 1873. In 1878 he came back to Paris as Professor of Physics and Meteorology in the Institute Agronomique, and in 1888 he was appointed Professor of Biological Chemistry in the Faculty of Science. M. Duclaux took the degree of Doctor of Science in 1862; but, like Pasteur himself, he is not a member of the medical profession, although in 1894 he was elected a member of the Academy of Medicine. He is the editor of the Annales de l'Institut Pasteur. Apart from his contributions to chemistry, silkworm culture, the phylloxera, etc., he has done valuable work on ferments and their relation to disease, digestion, milk, and microbiology.

The Feeding of Infants.—The time when a bottle-fed baby was a rare thing is within the memory of all of the older physicians; but now it is the exception rather than the rule for a mother to suckle her child. Many a mother who really wants to nurse her baby, but because of her small supply of milk is prevented, might, by a little judicious advice as to diet and proper habits, be rendered perfectly competent. Instead of this, that convenient bottle is adopted, which is thus graphically described by Dr. Mary A. Willard: "When the poor, pinched, blue, weazened little creatures were brought to me in the dispensary in New York, where they used to come by the dozen, I would call for their nursing-bottles, take a whiff of their sour, putrid contents, swarming with bacteria, pull off the rubber nipple and the ivory guard, rip up the long tube with my penknife, and scrape off the green, poisonous matter, tyrotoxicon, and spread it out on my palm before the astonished mother." Combine with such a state of affairs in the bottle some one of the dry milk foods, or a diluted condensed milk, and the babies' chances are pretty slim. The dry milk powders, including malted milk, are, from their nature, deficient in fats and contain a large excess of sugar, which is harmful because of the readiness with which it undergoes fermentation. As for the condensed milks, during a recent examination of the milk supply of London, seventeen brands were examined; fourteen of these were found to have been prepared entirely from skimmed milk, and showed an average of only 0·72 per cent of fat. Genuine full-cream brands of condensed milk contain from ten to twelve per cent of fat. Considering the far-reaching and deplorable effects which reliance upon such foods must lead to, it is of the utmost importance that physicians and parents should understand the dangers of prepared-milk feeding.

Examinations.—From a recent address delivered by Jonathan Hutchinson, and published in the Lancet, we quote the following very pertinent passages: "Examinations should be made as little distasteful as possible. The candidate ought to feel throughout his studies that in presenting himself to an examiner he does that which is equivalent to placing himself on a weighing machine, and that the verdict recorded will be in exact relation to his deserts. . . . The personal element, that of the examiner, should be eliminated as far as possible. To this end *viva-voce* examinations should, as far as practicable, be avoided. I have heard a self-confident examiner allege that he could tell better what was in a man in five minutes' conversation than by reading any number of his written papers, and I did not doubt that he thought so. This judgment of men, as it were, by personal inspection is often most fallacious, and should be permitted only with the utmost circumspection. It by no means follows that the disuse of the *viva voce* would throw us back wholly on set verbal questions. There remains the extensive field of objective examination. . . . This kind of examination it is which conduces most of all to sound matter-of-fact objective teaching. It is perhaps the most important of all modes,

and is one which in the future is destined to receive more and more attention. We come next to the consideration of papers and of paper-setting. It is the fashion to hold that any one who knows his subject can examine in it, but in truth it is not so, and the art of examining is one which, like other arts, needs to be learned. It is impossible to deny that many examination papers are ill expressed, and some wholly unsuitable. It is no legitimate part of an examination to take the candidate by surprise, or confound him with the unexpected. Nor should half of the time allowed be taken up in the effort to understand what the terms of the question are intended to mean. . . . Modern education, in its zeal to avoid the charge of being superficial, incurs, as it seems to me, that of being merely fragmentary. It aims at thoroughness, but is obliged at once to admit that it can attain it only in certain subjects which, compared with the sum of human knowledge, are but few and small. . . . Excepting a very few of us, we are all mere smatterers as regards almost all that we think we know. It is not possible to be otherwise, excepting at the cost of being wholly ignorant in many directions; and as regards fitness for the affairs of life, better by far a general acquaintance with all that is around us, though it be not very deep, than slices of profound knowledge placed sandwichwise between thick layers of utter ignorance."

Hygiene of Oysters.—Prof. Herdman and Prof. Bryce have found, from experiments on the effect upon oysters of various conditions—with especial reference to the typhoid germ—that beneficial results are derived from aëration, and therefore that it is salutary to lay the mollusks down where there is a good change of water. Of foods given to oysters, sugar caused them to lose weight and die; oatmeal and flour had like effects. Stagnation was deleterious, causing the accumulation of excretory products, and encouraging the growth of micro-organisms and the formation of scums on the surface of the water; yet the oysters were tolerant of sewage, and could, up to a certain point, render water clear that was contaminated with it, and they could live a long time in water rendered opaque by fecal matter. The fecal matter from typhoid subjects was more inimical than that obtained from healthy ones. The oysters were found very prone to infection by micro-organisms, but the typhoid bacillus will not flourish in clean sea-water; and the experiments seem to show that this organism decreases in numbers in passing through the alimentary canal of the oyster. It seems possible, therefore, that by methods similar to those employed in the clearing basins of the French ostreoculturists oysters previously contaminated with sewage can be freed from pathogenic organisms or their products without being spoiled for the market.

Bibliography of Zoology.—The International Bibliographical Bureau for Zoölogy, the organization of which was begun about three years ago, will be located, Mr. H. H. Field announces, at Zurich, Switzerland. It will publish a fortnightly bibliographical Bulletin, with an edition printed on thin paper and on only one side of the sheet, so that it may be cut up; and a complete card catalogue of all zoölogical literature published after 1895; besides which the *Zoologische Jahresbericht* will be federated with the undertaking, so as to afford an annual list of titles, arranged alphabetically, by authors. The bureau will be aided in various parts of the world by national committees, correspondents, and sub-bureaus.

Engineering as an Exact Science.—So far as it is based on mathematics, said Mr. L. F. Vernon Harcourt in the British Association, engineering is an exact science, and the strains due to given loads on a structure can be accurately determined; but the strength of the materials employed has to be ascertained before any structure can be properly designed. Accordingly, the resistance of materials to tension, compression, and flexure has to be tested and their limit of elasticity and breaking weight to be determined. Numberless experiments have been made on the flow of water in open channels, over weirs, through orifices, and along pipes, and the influences of the nature of the bed, the slope, depth, and size of the channel have been investigated. Electrical engineering is especially adapted for experimental investigation, but every branch of engineering science is more or less capable

of being advanced in the same way; and when it is borne in mind that the force of waves, the ebb and flow of tides in rivers, the influence of training works in estuaries, and the motion of ships at sea have been subjected to experimental research, it appears impossible to assign a limit to the range of experiments as a means of extending engineering knowledge. The correct calculations of strains, the exact strength of materials, and a strict appreciation of the physical laws affecting designs are of the utmost importance, and the failure of many bridges might be explained by a neglect of these considerations. Occasionally failures of works might be attributed to exceptional causes or peculiarly unfavorable conditions, but in most cases they are the result of errors or deficiencies in design which might have been avoided by a more correct appreciation of the physical conditions involved.

Electrical Effects of Spray.—A correspondent, writing to us concerning the effect of various atmospheric conditions on health and bodily vigor, cites his own experience in a fire brigade as having led him to believe that deficiency of ozone and other unfavorable conditions and the effect of atmospheric impurities may be alleviated by inhalation through a spray of cold water. A method of ventilation of railroad cars which was very comfortable to passengers riding in cars so treated, but has been disused, depended upon the application of this principle. Its value is further confirmed by what Prince Kropotkin has said in one of his recent articles on current science concerning the theory of the development of electricity by spattering water. A few years ago Herr Lenard undertook a series of observations in Switzerland on the electrical effect of waterfalls. It appeared that even small cataracts, only a few feet high, send into the air considerable charges of electricity, provided they bring down a large amount of rapidly dashing water. The smallest jets of water that drip on the rock sides, and even roaring streamlets, have the same effect. He suggested that the chief cause of electrification is the tearing asunder of the drops of water as they fall on the wet surfaces at the bottom of the waterfall. The experiments on which these views are founded accord with the demonstration by Lord Kelvin and Messrs. Maclean and Goto that air, even absolutely dust free, can be electrified by a jet of water. This source of electrification is further shown to be by no means insignificant, and the amount of electricity sent into the air in this way is immense. The importance of these facts in the economy of Nature, says Prince Kropotkin, is self-evident. "The supply of electricity in the air is continually renewed. The waterfalls in the valleys, the splashing of the waves on the shores of lakes and rivers, and the splash of drops of rain on the ground send masses of negative electricity into the air; even the watering of our streets and of our plants in the orchards has the same effect on a limited scale. On the other side, the waves of the sea, as they break against the rocks and fall back in millions of droplets upon the beach, supply the air with masses of positive electricity the amount of which rapidly increases after each storm. And when we stand on a sea beach we not only inhale pure ozonified or iodized air; we are, so to say, surrounded by an electrified atmosphere, which, as already remarked by Humboldt and often confirmed since, must have a stimulating effect upon our nervous activity as well as upon the circulation of sap in plants."

The Sciences Auxiliary to Engineering.—Among the branches of science necessary for the engineer, Mr. L. F. Vernon Harcourt, in his address at the British Association meeting, named mathematics and physics as of the highest importance, and as those upon which the profession mainly depends. Other sciences of considerable though comparatively minor importance are those of chemistry, meteorology, and geology. All branches of applied mathematics have to be used by engineers, or, as in the case of several general principles and tidal calculations, by mathematicians, for their benefit; but graphic statics will probably gradually supersede analytical methods for the calculation of stresses, as more rapid and less liable to errors, which are also more easily detected in graphic diagrams Pure mathematics, in its higher branches, appears to have a less direct connection with engineering; but applied mathematics is so largely dependent upon pure mathematics

that this, including the calculus and differential equations, can not be safely neglected by the engineer—though some of the more abstruse portions of the subject might be dispensed with. Physics is of great importance, for there are few problems in engineering in which no part is borne by physical considerations. The surveyor avails himself of physics when heights are measured by the barometer, or by the temperature at which water boils. Evaporation, condensation, and latent heat bear upon the efficiency of steam engines, and the expansive force of gases, the retention of the heat developed, and the diminution of friction on the economical working of heat engines. Considerations of temperature limit the height to which railways can be carried without danger of blocking by snow, and the depth at which tunnels can be driven. Compressed air is largely used by engineers. Electric engineering, too, is intimately connected with physics. Chemistry is of importance in the manufacture of iron, steel, and other metals, and the formation of alloys, and in its relation to explosives. A knowledge of geology is indispensable in directing a search for coal, iron ore, and the metals, and in the execution of all works going below the surface. Meteorology is useful to the engineer in that it enables him to know the force of the wind and the direction, duration, and periods of occurrence of severe gales—very important matters in the construction of bridges and harbor works.

A Valley of White Limestone.—A remarkable formation is described by Mr. Theodore Bent as observed by him while exploring the frankincense country of Arabia, near the presumed site of the Abyssapolis of Ptolemy. The valley leading down to the Red Sea has been filled in the course of ages by a calcareous deposit, which is collected on either side of an isolated hill in the middle of the hollow, about one thousand feet in height. This deposit has taken the form of a straight and precipitous wall five hundred and fifty feet high and three quarters of a mile long on the eastern side of the hill, and about a quarter of a mile long and three hundred feet high on the western side. Over these walls feathery waterfalls precipitate themselves, adding perpetually to the chalky accretions of which the cliffs are constructed. The general appearance of the walls is white and whitish-gray, with long, white stalactites hanging down in tumbled confusion. They are streaked here and there, where the water perpetually falls, with patches of green. Beneath plateaus twenty feet high enormous ricinuses, daturas, and other plants flourish; and the Bedouins have utilized the stream before it has lost itself in the rocky channel to make small gardens. The rocky channel below is also very curious, presenting a flat surface about fifty yards across of white calcareous rocks, while just below the wall where the water comes down is an enormous amount of white calcareous deposit, soft and spongy to walk upon. Mr. Bent pronounces this one of the most stupendous natural phenomena he has ever seen, characterizes the valley as "a stupendous abyss," and compares the whole with the pink and white terraces of New Zealand and the calcareous deposits of Yellowstone Park.

Geology and Paleontology at Union University.—The department of Geology and Paleontology of Union University offers the ordinary course of the college and special courses for such students as are interested in the science from a philosophical or professional point of view. The courses include mineralogy and lithology, general geology (with excursions), economic geology, in which are considered in the second half the occurrence and distribution of the mineral deposits and building stones of the United States; systematic and structural geology and paleontology, with especial consideration of the formations occurring in New York and adjacent States and their characteristic fossils; field and laboratory study of the geological formations readily accessible from Schenectady; the methods of preparing geological maps and reports; and advanced field work and independent research, in which the student selects some region for original work to which he can devote considerable time, and conducts his investigation in a professional manner. He is expected in this to demonstrate his ability to conduct original work, and to prepare a report containing a summary of the previous knowledge of the geology of the region, with

a detailed account of his investigations—the whole to constitute a contribution to knowledge. In studying paleontology the student receives careful training in systematic classification. Candidates for honors must prepare theses of sufficient merit to warrant the publication of at least an abstract in some scientific journal. As aids, students have access to the library and museum of Union College, and to the State Library and Museum at Albany.

Antiquity of the Quichuas.—Dr. George A. Dorsey expresses his belief, in a paper on The Character and Antiquity of Peruvian Civilization, that the Quichuas came into Peru from the north, and that the time of their arrival must have been a great while ago, "perhaps several thousand years. The fact that they had thoroughly domesticated the llama as well as other smaller animals is in itself proof of great antiquity. The same holds true in regard to the high state of cultivation in which we find the cotton plant, several varieties of maize, and other cereals and food products. In the province of Huarochiri, Avila states that the origin of the great acequias and irrigating canals was only accounted for by a myth, their construction dating back to so remote a period that they were no longer ascribed to human agency."

MINOR PARAGRAPHS.

THROUGH the co-operation of some private persons interested in the preservation of species and the Linnæan and other societies of New York, protection has been afforded to the terns on Great Gull Island, Long Island Sound. A sum of money was contributed to employ a gamekeeper, and the lighthouse keeper on Little Gull Island was authorized to act in that capacity. From three to four thousand birds were found on the island in 1886. They had been since diminishing year by year in numbers under the attacks of sportsmen and egg-hunters, till attention was called to the fact and a watch was placed over them. Under the care of the gamekeeper the numbers of the colony increased at least one half during 1894, and terns are now seen where they had not been observed for many years before.

WERE Indians of the Sioux stock ever settled in the East? is asked by James Mooney, who finds evidences in languages that such tribes once lived in a particular territory in Virginia and the Carolinas. Traditions are cited in his paper on the subject, which are said to exist among some of the Sioux tribes, of a former residence on the Ohio, and of a migration prompted by the density of the population, which had become too numerous for the hunting grounds. The emigration was probably prehistoric, as the Sioux tribes were established in the West as early as three hundred and fifty years ago, and was caused, Mr. Mooney thinks, not by the disappearance of game—for the buffalo did not become extinct in the Ohio Valley till late in the last century—but by the pressure of hostile tribes from the north and south—Algonkins and Muskogees.

THE encouraging fact is brought out in the reports of examinations published by the Regents of the University of the State of New York that a rapid and healthy increase is going on in the standard of proficiency of the candidates in all the grades. Even more significant than this is the evidence that desultory courses of study are giving way to longer and reasonably balanced courses. A very beneficent influence is exerted it is alleged by the new laws and regulations requiring candidates for admission to practice in law, medicine, and dentistry to submit evidence of a general preliminary education equivalent to a full high-school course.

FROM certain manuscripts left by Dalton, to which attention is called by Sir Henry Roscoe and Dr. A. Harden, it is made clear that his application of the atomic theory to chemistry was not the result of his own analysis of certain compounds of carbon, as has hitherto been supposed, but that his mind was saturated with Newton's notions on atoms, and he worked out the theory from physical conditions as to the constitution of gases. Somewhat later he quoted numerical results, not of his own, but of other chemists' analyses, in support of the theory, and seems to have worked out the law of chemical combination in multiple proportions as

the only conceivable mode of combination between atoms.

THE results of the experiments of 1894 at the New York Agricultural Experiment Station on spraying indicate that the dilute Bordeaux mixture when thoroughly applied is a practical preventive of pear scab. The treatment has been equally effectual in preventing apple scab and codlin moth. Some roughness, regarded as injury, appeared on the sprayed fruit, but it has not been determined whether this was caused by the Bordeaux mixture, by substances mixed with it, by the weather, or by some other cause. Some of the trees sprayed in 1893 overbore, and consequently did not produce as full crops in 1894; the only inference deducible from which is that spraying will not prevent the reaction that follows an excessive crop.

NOTES.

MEERSCHAUM is extracted in much the same way as coal. Near Eski-Shehir, an important station on the Anatolian Railway, where rich deposits of meerschaum are found, pits from twenty-five to one hundred and twenty feet deep are dug, and as soon as the vein is struck horizontal galleries, sometimes of considerable length, are made. The stone as extracted is called *ham-tash* (rough block), and is soft enough to be easily cut with a knife. It is white, with a yellowish tint, and is covered with a red, clayey soil. The manipulation required before it is ready for export is long and costly.

THE average annual production of wine in Spain, including the Balearic Isles and the Canaries, is estimated at 770,000,000 gallons. The principal wine-growing districts are in Valencia, Catalonia, Old Castile, Aragon, Riojana, Navarre, Leon, Andalusia, Estramadura, and the largest production is furnished by the provinces of Alicante and Valencia-Catalonia. Andalusia produces the famous sherry and Malaga wines which compete very favorably in the foreign markets with the Italian products of Marsala and Syracuse. The amount of sherry alone which is shipped from Spain each year represents a value of over $12,000,000.

ANIMALS in Mediæval Architecture, profusely illustrated, and The Criminal Prosecution of Animals in the Middle Ages, also illustrated, are the titles of two interesting volumes by Prof. E. P. Evans soon to be published by Henry Holt & Co., New York, and William Heinemann, London.

THE following sentence from one of Pasteur's speeches seems worthy of widespread circulation: "I hold the invincible belief that science and peace will be victorious over ignorance and war; that the nations will agree not to destroy, but to build up; and that the future will belong to those who shall have done most for suffering humanity."

THE part which ants play in the *ménage* of an orchid seems to be essential to its healthy growth. Mr. J. H. Hart, dealing with this question in a recent bulletin of the Royal Botanic Gardens, says that while there are several theories as to the part which the ants play, probably the correct one is that they supply the roots of the orchid with the mycelium of a fungus, which fungus enables them to take up food which would be otherwise unattainable.

THE third International Congress of Psychology will meet in Munich next August. The opening will take place in the great hall of the university on the morning of the 4th. Prof. Stumpf is the president of the congress. Information may be obtained from the general secretary, Freiherr von Schrenck-Notzing, or from Prof. Sully, East Heath Road, Hampstead, London, England.

IT is stated that a biography of Prof. Huxley is being prepared by his son, Mr. Leonard Huxley, who will be greatly obliged if those who possess letters or other documents of interest will forward them to him at Charterhouse, Godalming. They will be carefully returned after being copied.

DR. ROBERT BROWN, who died in Streatham, England, October 26, 1895, in his fifty-fourth year, was a man of much versatility in science. He studied at the Universities of Edinburgh, Leyden, Copenhagen, and Rostock. Visiting Spitzbergen, Greenland, and Baffin Bay in 1861, he made some notable discoveries. During the next five years he traveled through some of the unexplored districts of America, visiting the West Indies, Venezuela, Alaska, Bering Sea, and places between, and the Pacific islands. He was botanist to the British Columbia expedition and commander of the Vancouver Island expedition. In these enterprises he introduced several new plants into Europe. He charted the interior of Vancouver Island, then unknown. With Mr. Whymper he made the first attempt of Englishmen in 1867 to penetrate the inland ice of Greenland. He afterward traveled extensively through the Barbary states; then settled down in Scotland, where he lectured to various institutions on geology, botany, and zoology; and later engaged in newspaper work in England. His name has been given to several new species of plants and animals, and to at least five geographical points in Vancouver Island, Spitzbergen, and Nova Zembla. He was the author of several scientific and other books, and an honorary or ordinary member of many learned societies.